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# RELIABILITY HANDBOOK

BY

A. BULFINCH

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RELIABILITY CONCEPTS SECTION

QUALITY ASSURANCE DIVISION

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## PREFACE

This handbook is intended as a guide for determining reliability of functioning characteristics of weapon components by testing to failure.

Component reliability of weapon systems is basically a function of engineering design. Margins of safety used in engineering design to create high reliabilities must be measured by testing to failure techniques to obtain unbiased estimates of reliability.

The author does not hold that the concepts and principles presented herein are final. Revisions will inevitably be made as the state of the art advances.


## ACKNOWLEDGEMENTS

The following tables have been used thru the kind permission of the publishers and authors:

Appendix 3A

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Appendix 3B Table I

Lipow, M. and Riley, J., "Tables of Upper Confidence Limits on Failure Probability of 1, 2, and 3 Component Serial Systems", Space Technology Laboratories, Inc., PO Box 95001, Los Angeles 45, Cal.; Volume I: Tables for k= 1 and $n$ = 5 thru $n$ = 200; Volume II: Tables for k= 1 and $n$ = 210 thru $n$ = 1000.

Appendix 3C and 3F

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Appendix 3D

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Appendix 3E

Merrington, M, and Thompson, C. M., "Tables of Percentage Points of the Inverted Beta (F) Distribution", Biometrika, Volume 33 (1946) pages 78 thru 87; Biometrika Office, University College, London.

Appendix 4 (Multifactorials)

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Appendix 3G

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Appendix 3H

Odell, P.L., "Tables and Graphs for Determining an Upper Confidence Bound on the Number of Defectives in a Finite Population", U.S. Naval Nuclear Ordnance Evaluation Unit, Albuquerque, N.M.; Table I, page 9; Table 2, page 10; Table 4, page 14; Table 9, page 33; Table II, page 43; Table 14, page 52; Table 17, page 85; Table 19, page 103; and Table 24, page 156.

Appendix 4 (Fractional Factorials)

U.S. Dept of Commerce, National Bureau of Standards, "Fractional Factorial Experiment Designs for Factors at Two Levels", Applied Mathematics Series 48, Superintendent of Documents, U.S. Printing Office, Washington 25, D.C.

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SUMMARY

1. The following are set forth:

a. The concept of reliability of functioning characteristics of weapon components in terms of stress and strength.

b. The operating engineering definition of reliability.

c. The complex nature of reliability.

d. Ultimate reliability in terms of safety margins.

e. The relationship between test and use conditions.

f. The limitations of reliability determinations imposed by testing facilities, information and cost.

2. A two-phase testing procedure which meets the need for demonstrating high reliabilities with small sample sizes is described in a rational, objective manner. The first phase involves use of fractional-factorial experimental designs to survey effects of important environments. The second phase is a test-to-failure procedure (using the environment found most severe in the first phase) so conducted that reliability-in-use can be calculated from test results.

3. The need to plan experiments in advance of data collection and, to test to failure are emphasized. The requirements of a good experiment are treated.

4. Several useful fractional-factorial test plans are completely laid out in the form of treatment procedures. Tests of increased severity most useful in testing to failure are described. Examples are given for applying these methods.

5. Useful statistical tables, a glossary of terms, and a list of references are included.

## I INTRODUCTION

This manual has been prepared for those engineers and scientists conducting reliability experiments who would like to use statistical techniques to improve the efficiency of their experiments. However, it is advisable, especially in the planning stages of testing programs, to supplement the information in this manual by occasional consultations with a statistician.

Planning experiments in the modern statistical sense compels the experimenter explicitly to formulate his objectives and the procedures required to attain them. This often leads to the recognition of fallacies and other difficulties in advance of data collecting.

The statistical aspects of reliability are not new. All of the necessary concepts are adequately treated in modern statistical literature. The lack of information about measurable characteristics of the missile system and the environment it experiences in use, as well as the high cost of test specimens, have created the current problems.

The techniques described in this manual are the most efficient known. They are designed to maximize the amount of information obtainable from a given sample size. Very high reliabilities (0.9999 and higher if they exist) can be demonstrated from very small sample sizes (25 to 30 items.) In addition,

these techniques are definitive enough to serve as standard procedures throughout the same or different organizations over extended periods of time.

Uniform application of these techniques is as important as their efficiency. A large part of the value of experimentally determined reliability data is the scope of applicability. Reliability data collected by means of standardized procedures are cumulative in the mathematical sense. Hence, the precision with which reliability values are known can be improved with time as additional data are collected. This makes it possible to accumulate a reference file of reliability data on a variety of standard components.

For those readers not thoroughly familiar with statistical terms a glossary of these terms has been included in Appendix 2.

## 1. RELIABILITY CONCEPT

It is assumed that for every missile component there exists a true but unknown "strength" created by the particular (parts) design developed and used by the engineer in building the component. It is further assumed that the true "strength" is a constant and not a random variable for any particular design over short periods of time.

An item will not fail until the applied stress exceeds the items "strength ." If the "strength" is much greater than the stress expected to be experienced in use, the chance (probability) of failure in use in very small, and the chance

of success (reliability) is very high. It is in this sense that "high reliability" is defined. That is, high reliability means high probability of successful functioning under actual <u>use</u> conditions; it does not mean high reliability under the <u>test</u> conditions.

## 2. RELIABILITY DEFINITION

The accepted statistical definition of reliability is that reliability is "the probability of successful functioning in use." This is a general definition that is applicable to any operating system. However, to define reliability from an operating engineering point of view, the general definition must be modified to include:

a. The environmental conditions under which successful functioning is required.

b. The characteristics that are required to function successfully.

c. The length of time or the number of times successful functioning is required.

d. When successful functioning is required.

This means that every component can have as many reliabilities as a number equal to the possible combinations of environmental conditions, measurable characteristics and functioning times.

Under the definition that an item cannot fail until the stress exceeds its strength, the reliability with respect to any environment can be determined only if the test specimens are stressed by that environment until

failure is obtained. This means that successively higher levels of severity must be used until failure is obtained, as in the applications of successively greater loads until failure is obtained in a tensile test. When the magnitude of the stress at the point of failure cannot be directly observed, then an exploratory type test such as the Bruceton up-and-down method is required. This procedure generates the failure rate curve from which the average (ultimate) strength (the point at which the stress equals the strength) can be obtained by finding the stress at which 50 percent of the items fail. In any case the ultimate strength of an item is determined in such a manner that the reliability-in-use can be predicted from the test results.

## 3. LIMITATIONS

### A. Laboratory Testing

In laboratory testing, it is difficult to reproduce the conditions which components will experience operationally. In use, several environments occur simultaneously; in the laboratory, the environments usually have to be applied in sequence. As a result, the environment experienced in use is more severe than that applied at comparable levels of severity in the laboratory. Furthermore, interactions among environments and among components raise the level of severity experienced in use by an additional amount. The extent to which the level of severity is increased in these cases is usually not known.

To cope with unknowns of this kind, engineers use "margins (or factors) of safety" to assure successful functioning in use. As a rational consequence, testing procedures used to test components must, to be of any value, determine

the actual margins of safety the engineers have succeeded in building into the new item. To accomplish this, with the limitations imposed by cost considerations, careful planning prior to data collection is required. Useful and realistic component reliability values cannot be obtained by accident or as a by-product of a testing program designed for some other purpose, such as controlling quality. However, reliability values can supplement but not replace quality control and other engineering information.

B. Information

A complicated system of any kind cannot be fully characterized or described by a single numerical value. Just as the "whole man" cannot be fully described by an intelligence quotient, a whole missile system cannot be fully described or characterized by a single reliability value. Fully to characterize the expected performance of a missile, all possible reliabilities should be:

a. Determined and weighted in accordance with:

(1) Their engineering importance,

(2) Probability of occurrence of the various environments,

(3) Duration and intensity of the environment,

(4) Presence of interaction among environments and among components, and

b. Mathematically combined:

(1) In accordance with the way the environments occur (i.e., simultaneously, in combination, or in sequence),

(2) In various ways to predict the probability of successful functioning of the major and minor subassemblies,

(3) In accordance with the system circuitry to predict the reliabilities of the over-all system.

C. Cost

The cost of measuring the magnitude and interaction effects of the multitude of variables affecting performance of complex missile systems is prohibitive, as is the cost of determining all of an item's possible reliability values, or even a large number of these values. These costs will perhaps remain prohibitive as long as there is a reasonable alternative.

## 4. SAFETY MARGINS

The use of safety margins to assure successful functioning under unpredictable conditions is not new. Currently, reliance is placed on the "safety factor" or the "margin of safety" as an alternative for information. If the expected nominal "stress" (or load) in use is 100 units, designing an item with the "strength" to withstand several times this "stress" gives intuitive assurance that the item will function successfully without failure (i.e., be reliable). Such an item will surely withstand 100 units of "stress" (be highly reliable under this condition) and has a good chance of functioning successfully even when the applied "stress" varies widely, the quality of the material is substandard, or the workmanship is poor. A large margin of safety, then, is a means of assuring successful functioning in the presence of uncontrolled and indeterminate variations in environment, materials, and workmanship. This concept of "stress" and "strength" can be used as a corollary

to the definition of reliability given above: An item cannot fail until the stress exceeds its strength. The point at which the stress equals the strength measures the average (ultimate) strength. At this point the reliability equals 50 percent. To raise the reliability above this level, the strength must exceed the expected in-use stress. High strength relative to the stress means high reliability, since the higher the strength, the less likely a failure is to occur.

Construction engineers design an item to withstand several times the load expected in use (for the above reasons), then evaluate the design by measuring the safety factor of a few representative specimens. This can only be done by applying a load until the specimens break, or fail in some other manner. The breaking load is a measure of the ultimate strength. The "safety factor" is the ultimate strength divided by the load expected in use. The "margin of safety" is the difference between those two loads divided by the expected load in use. Calculating either of these values is as far as construction engineers usually go; they do not calculate a numerical value for the probability of success in use (reliability) created by the safety factor. If the safety factor is large, they feel confident in concluding (predicting) the item will not fail in use.

Missile engineers also use safety margins. They design margins of safety into missile components in many subtle ways and for the same reasons: to assure successful performance in use under uncontrolled and unpredictable conditions. Here, too, the "margin of safety" designed into an item can only be determined by testing to failure. The "stress" required to cause failure can also be termed ultimate "strength."

## 5. ULTIMATE RELIABILITY

The reliability obtained by testing to failure is the ultimate (maximum) reliability, whether a margin of safety is used or not. This is the only unbiased measure of the true reliability created by the design of the item.

Testing without failure demonstrates reliability only in proportion to the number of test specimens used. This is a biased estimate of the ultimate reliability. This means that the ultimate reliability cannot be determined by testing a finite number of specimens without failure.

## 6. PLANNED EXPERIMENTS

When only one of the possible total number of reliabilities can be determined, the logical choice is to determine the minimum reliability. If the latter is satisfactory, all other possible reliabilities with respect to separate environments will also be satisfactory. Without a knowledge of the values of all reliabilities, meaningful and realistic system reliabilities can only be predicted from component reliabilities on the basis of the minimum reliabilities.

Experiments must be designed.* This requires planning in advance of data collection. Test plans must be specifically designed to assure, in advance of data collection, that specified objectives will be attained, for reliability can neither be tested, nor analyzed into an item.

* See Reference 12

Environmental conditions which cause the poorest (minimum) reliabilities can be found most efficiently (with smallest sample sizes) by means of fractional-factorial designs or their optimized modifications. The object here is to survey environments considered most important to the functioning of the item and to find the environment having the most severe effect (i.e., causing the lowest reliability). This environment is then used to determine the minimum ultimate reliability by testing to failure, using tests of increased severity.

## 7. TESTING WITHOUT FAILURE

The margin of safety designed into a missile component can be determined only by testing to failure. To do otherwise, practically nullifies the value of test results and makes the engineer's effort to use safety margins ineffective. If the test procedure does not measure safety margins, the engineer has no evidence that they exist, and may conclude that other means of increasing reliability (e.g., redundancy) must be used. This line of action is not only costly, but may create other problems, such as: misplaced center of gravity, overweight, and lack of space.

Testing without failure, which entails large sample sizes, is costly. By this method, it takes 460 items to demonstrate a reliability of at least 99.5 percent with 90 percent confidence. The same reliability can be demonstrated (if it exists in the item) with 25-30 items by testing to failure, using tests of increased severity. In addition the results of testing

without failure cause difficulty in calculating system reliability from component reliability because zeros cannot be mathematically manipulated.

Because testing without failure cannot measure ultimate reliability with small sample sizes, trends cannot be detected early enough for taking timely corrective action. For example, if the ultimate reliability of an item actually exceeds that specified in the military characteristics (0.995 or higher), and only 25 items are tested at the use condition without failure during each testing period, no trend will be detected until ultimate reliability of the lot, or stockpile, drops below 0.91 (at the 90 percent confidence level).

## 8. RELATION BETWEEN TEST AND USE CONDITIONS

To translate the reliability demonstrated under test conditions to a "reliability-in-use" value, the relation between the "use" and "test" conditions must be established. Experience has shown that this relationship can be adequately represented by frequency distributions. This places the relationship on a probabilistic basis, and also makes possible the use of the laws of probability. If then, the test results are properly collected (see Lab Test Methods), the reliability-in-use can be calculated by extrapolation..

## 9. TEST PLANS

Plans should be made to conduct experiments in two stages:

A. Factorial experiments:

For each type of component, the separate effects of the critical environments can be determined most efficiently in one integrated

factorial experiment. From these results, the environments having the most severe effects should be selected. When only attribute data can be obtained the optimum condition for conducting this experiment is at a level of severity at which approximately 50 percent of the test specimens can be expected to fail. This type of experiment is highly efficient. The effect of as many as 7 environments can be determined with 8 test specimens, or the effects of 15 environments with 16 test specimens.

B. Testing to Failure

Within the limitations imposed upon the experiment, determine the reliability with respect to as many as possible of the environments having the most severe effects. This can be accomplished most efficiently using a test of increased severity such as the Bruceton up-and-down method. It is only with this type of test that the ultimate "strength" can be determined when the occurrence of a failure cannot be detected by inspection or when the magnitude of the stress at the point of failure cannot be directly observed. From this information the predicted ultimate "reliability-in-use" can be calculated. Ultimate "reliability-in-use" of any magnitude that exists in an item can be demonstrated with as few as 25 to 30 test specimens by testing to failure with tests of increased severity.

## IV MODERN STATISTICAL CONCEPTS

### 1. INTRODUCTION

Because of the nature of reliability and because of the methods required to determine reliability, modern statistical concepts, such as probability, experimental error, population - sample relation, frequency distributions, confidence intervals, sample size, and design of experiment techniques must be understood, if reliability experiments are to be conducted and reliability values calculated and interpreted. It is only with these concepts that the vexing problem of demonstrating high reliabilities with small sample sizes can be solved.

Modern statistical methods of experimentation contain a new ingredient not explicit in mathematics: Error. The new philosophy assumes that there is an error in every measurement made and as a consequence, the true values of measurable characteristics can never be known exactly. To cope with this deficiency of measuring processes, repeated measurements are made. Then from this data an interval is calculated which we believe includes the true value represented by the data. Intervals of this kind are called confidence intervals.

Included in the method of calculating these intervals is a means of controlling the proportion of the time that the true value is expected to fall within the interval. Thus the name. This proportion expresses our "confidence" of being right in our prediction that the true value will fall in the interval calculated. Formulas for calculating confidence intervals are given below in Section IX: Reliability Confidence Intervals.

## 2. EXPERIMENTAL ERRORS

If the same characteristic is repeatedly measured with an "accurate" device under constant conditions, the same result will not always be obtained. As a matter of fact, the same result will seldom be repeated. However, it will be noticed that most of the values will cluster rather closely. Only a few very small and very large values will be obtained. It is assumed that these observed deviations are due to chance errors in the measuring process. They are called experimental errors.

## 3. POPULATION VS SAMPLE

The family of values generated by repeated measurements of the same characteristic is called a population. A population **is generally assumed** to be infinite. Any sub-portion of a population is called a sample of that population. A sample is always finite.

## 4. PREDICTION ERRORS

The reasoning behind the new philosophy is as follows: The observations or measurements made in any experiment are, in fact, finite samples of a much larger (infinite) body of data that could exist had thousands (infinite) of observations been made of the same characteristic under the same constant conditions. It is assumed that unless an infinite number of observations is made, the true value of the characteristic measured will never be exactly known. This reasoning requires focus of attention not on the observed values but on what these values represent -- the larger **family** of all possible values of the characteristic being measured. The objective is to infer from the sample something about the population. Experience has taught that prediction (an inference) cannot be made with certainty. There is always a chance of being **wrong. Errors of this type are called the prediction errors.**

## 5. FREQUENCY DISTRIBUTION

If all measurements referred to above are divided into small groups or cells having a range equal to about one-tenth the total range (from maximum to minimum) of all values, there will be about ten cells. Then if a count is taken of the number of values falling within the range of a particular cell, the ratio of this number to the total number of measurements available is the relative frequency of occurrence of measurements (events) in that cell. If the total number of measurements available is very large (1,000 or more) and all values falling within the cell are counted, a very good estimate of the true frequency of occurrence of values in that cell for that particular population will result. Doing this for all the cells would give values that could be plotted on a bar graph as follows: Arrange the cells along the abscissa in ascending order according to the magnitude of the midpoints of their range; erect bars over these mdipoints with height proportional to the relative frequency in each cell and widths equal to the cell width. This bar graph is known as a histogram.

## 6. NORMAL DISTRIBUTION

As the total number of values used is increased and the cell width (range) decreased, the step-wise form of the bar graph fades into a smooth curve that is called a frequency distribution. In practice, this is actually how a frequency distribution is formed. It means what the name implies. It is a distribution of (relative) frequencies.

Experience has shown that the families of values generated by repeated measurements of the same characteristic under controlled conditions have definite forms. The most common of these forms and the most useful is called the normal frequency distribution. This is the smooth curve described above. It is bell-shaped. The family of values forming this distribution is called the normal population.

As the cell width in the bar graph decreases and approaches zero, the height of the bar represents the relative frequency for a single value on the abscissa. Thus there is a relative frequency for any value in the population of measurements. The sum of all the frequencies equals the frequency of all the values in the population which is assigned the numerical value of one. The equation for this function is known, but it is of no direct importance for the purpose of this discussion. It can be found in any standard text on statistics.

## 7. PROBABILITY

From a practical point of view relative frequencies (proportions) are estimates of probabilities. By definition, if it is certain that an event will occur, it is said that the probability of occurrence is equal to unity. If it is certain that an event will not occur, it is said that the probability of occurrence is equal to zero.

In the above example, if the cell width was equal to the range of the population (from the maximum to the minimum value in the population) it would be certain that the next value taken would fall within this "cell." As a result of taking repeated measurements, all of the values would fall within

this "cell." The number of values falling within this "cell" divided by the total number of values will equal unity. That is, the probability of a value's falling within the "cell" (the event) is equal to one.

If, on the other hand, a new cell is taken having a maximum limit less than the minimum of the above population, it is certain that the next value taken from the above population will <u>not</u> fall within the new cell. If repeated measurements are taken from the above population, <u>none</u> of the values will fall within the new cell. The number of values falling within the cell divided by the total number of values will equal zero. That is, the probability of a value's falling within the cell (the event) is equal to zero.

The area under the normal frequency distribution is used to measure probabilities. As shown above, the magnitude of the ordinate associated with any value on the abscissa is a measure of the relative frequency of occurrence (or probability of occurrence) of that value. The summation of all the ordinates below any particular value on the abscissa is, of course, equal to the area under the curve below that ordinate. This area is then a measure of the probability of occurrence of all values in the population below the given value.

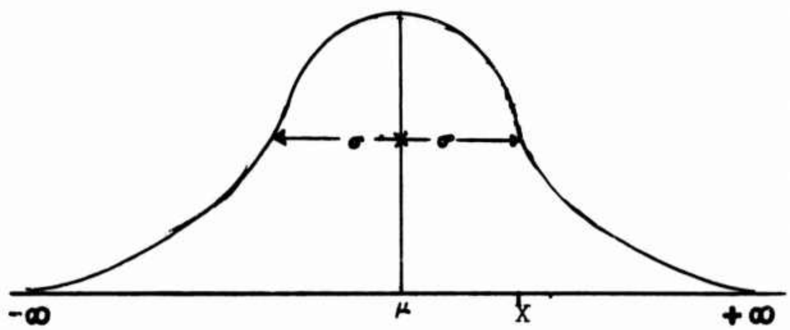
## 8. PARAMETERS

Just two parameters or characteristics of the normal frequency distribution are required to define this curve completely. The first parameter is the central value around which most of the values belonging to a particular population will naturally cluster. This parameter is called the true or population <u>mean</u> and is measured by the arithmetic average of <u>all</u> the values in the population. The other parameter required is the dispersion of values around the central value. This parameter is measured by the root mean square of the deviations from the true mean and is called the true or population <u>standard deviation</u>.

## 9. PROPERTIES OF NORMAL CURVE

Graphically, the mean is the ordinate that passes through the center of gravity of the area under the curve, since this curve is symmetrical. The mean is equal to the mode (the most frequently occurring value) and the median (the middle value.)

Also, graphically, the standard deviation is equal to the horizontal distance between the ordinate of the mean and the inflection point on the curve on either side of the mean ordinate.




The Normal Deviate:
$Z = (x - \mu)/\sigma$
This is the linear measure of distance along the base of the curve in standard deviation units.

Where: $\mu$ = The true population mean.

$\sigma$ = The true population standard deviation.

X = Any observed value.

The true mean plus or minus one standard deviation includes 68.27 percent of the total area under the curve. The mean plus or minus two standard deviations will include 95.45 percent of the total area under the curve. These values are used to make probability statements. They mean either or both of the following:

A. In generating a normal family of values, 68 percent of the total number of values will lie within plus or minus one standard deviation of the mean. This is especially true if the total number is very large--i.e., 1,000 or more.

B. Randomly chosen values from the normal population have a 68 percent chance or a probability of 0.68 of falling within plus or minus one standard deviation of the mean.

This distribution is unique in nature. It is the curve of regression for the distribution of all small sample averages.

## 10. RANDOMIZATION

The meaning of the word random as used in modern statistics can be better described than defined. The phrase "randomly chosen values" describes a selection procedure of a very special kind. This procedure is free of biases of all sorts. It is the only procedure which will permit the free play of chance variations, which are the theoretical basis for all modern statistical techniques.

Random selection or random sampling can be accomplished by physically mixing the items before sampling, or by numbering all of the items and then using a table of random numbers to determine which items to select and in what order to select them. Random selection is the process used in lotteries, all numbered tickets being deposited in a revolving drum and a single drawing made by a blindfolded person. It is assumed that such a procedure is completely unbiased, that chance alone is at play, and that each ticket in the drum has an equal chance of being selected. The process of random selection then, not only permits the laws

of chance to determine which item is to be chosen, but also the order in which successive items are chosen. This procedure relieves the experimenter completely of any responsibility concerning "which item" and "which order." In the lottery, the operator wants to be "fair." In an experiment, the experimenter wants to be unbiased.

## 11. SAMPLING

In a lottery the relative frequency of occurrence of any particular number is equal to the relative frequency of occurrence of any other number in the drum (population). Each number has an equal chance of being selected if the selection procedure is truly random and unbiased. However, the relative frequency of occurrence of the values in a normal population is not equal. Theoretically, all are different. A little reflection will show, however, that random selection will be "fair" and unbiased here, also. If in a bowl, 900 white beads and 100 red beads are mixed well (i.e., randomized), and a handful of beads selected by a blindfolded person, the ratio of red to white beads in that or any other handful will be close to 1 to 9. The average ratio of a large number of trials (handfuls) will be 1 to 9 -- the relative frequencies of the two colored beads in the bowl, the population. This same relation between sample and population holds true in selecting (sampling) values from a normal distribution if sampling is done in a random fashion. That is, every value (or item) in the population has a chance (probability) of being selected equal to the frequency with which it actually exists in the population. Only samples that can reflect these actual relative frequencies in the population can be

considered as representing the population in an unbiased manner. Samples must correctly represent the population from which they are taken if valid inferences are to be made about the population, from the sample. Of course, successive samples drawn from the same population will not be identical, but if randomly selected, the difference between them will be due to chance errors only. Under these circumstances modern statistical techniques will identify them as having come from the same population, which, in fact, they did.

## 12. ESTIMATES

In practice, to make a measurement (or observation) is to estimate the true population mean. The more observations made and averaged together, the better the estimate. This estimate is called a "point estimate" to distinguish it from an "interval estimate." However, it is assumed that the true mean is never known exactly unless an infinite number of observations is made.

If the root mean square of the deviations of the individual observations is calculated from the average of all observations, the true population standard deviation can be estimated. As with the mean, however, it is assumed that this true parameter is never known exactly unless an infinite number of observations is made.

## 13. PREDICTIONS

The two predictions made most often in modern statistics are the following:

A. The magnitude of the true parameters. These predictions are based on interval estimates which are called confidence intervals.

B. Whether two or more values belong to the same population. These predictions are called tests of significance.

The prediction problem in modern statistics is to estimate first the population mean and standard deviation and then predict what these two population parameters might be or, given two or more estimates, to predict whether they came from the same population. If there are thousands of observations in each of the samples, the sample means and standard deviations are, for all practical purposes, equal to the population parameters and prediction becomes unnecessary. In practice, however, such large samples are generally not available. They are too costly to obtain. The problem, then, is to predict from small samples what the parameters might be or whether the samples came from the same population.

Intuitively, it is known that predictions cannot be made with certainty -- there is always a possibility of being wrong. As a result, to be right as often as possible, reliance is placed on planning. In modern statistics, this possibility is maximized, and chances of being right are actually controlled.

To place this on a mathematical basis the assumption is made that the data have a normal frequency distribution. The normal distribution is then used to calculate the probability of being right in making predictions. This is called the confidence level of predictions. The techniques of modern statistics have been developed to make predictions. The assumption that the distribution is normal for variable (measured) data is a reasonable one. Experience has shown that the numerical values of measurable characteristics of products manufactured

under controlled conditions are normally distributed (Ref. 11). In addition, the central limit theorem states that the distribution of averages of variable data is normal. So, when comparing averages or calculating confidence intervals of measured data, the assumption of normality is quite valid. This is true of attribute (counted) data only where they are transformed to variable data by some such process as the arc-sine transformation.

## III REQUIREMENTS FOR A GOOD EXPERIMENT

### 1. PREDESIGN PHASE

A. Common Sense

Experimental plans and experimental results that violate common sense are discarded, not the common sense.

B. Past Experience

Use all available knowledge and information from past experience.

C. Choice of Variables

Make a comprehensive list of all the variables (factors or environmental treatments) whose effects on the components functioning characteristics are of interest or must be determined. This should include:

a. Factors of direct interest.

b. Factors which may help show how the main factors work.

c. Factors required to determine the effect of experimental technique. In addition to choosing the variables to be used, their order of use must also be established. The order chosen should be the one most likely to be experienced in use or the one considered most severe. The order selected must be held constant throughout the experiment.

D. Choice of Factor Levels

a. Number of levels

The number of levels used in the designs described in this manual has been limited to two. These designs are the simplest and the most versatile for conducting multi-factor experiments.

b. Position of levels

In using only two levels those used are usually the extremes, such as the presence and absence of an environmental treatment or extremely low and high temperatures. The choice of levels used must be arrived at through the use of good judgement, common sense, and detailed knowledge of the purpose and probable outcome of the investigation. Factorial experiments are most efficient in their ability to detect differences among environmental effects when the levels of severity used are such that approximately 50 percent of the test specimens fail.

E. Scope

Consider the entire scope of the problem. Without regard to cost, time, or effort consider what it is that must be known eventually. If this turns out to be a very large experiment, the cost of which is prohibitive, divide the whole problem into rational parts. This makes possible a systematically planned approach. It also makes it possible to relate your test plan to cost and the amount of information required.

F. Possible Outcomes

Consider all possible outcomes and their physical interpretation. Results that have no physical interpretation have no practical value.

G. Choice of Criteria

Choose carefully the criteria on which conclusions will be based. To insist that a component have a reliability of 0.999 with respect

to temperature shock is of little value when it has a reliability of only 0.80 with respect to transportation vibration.

H. Formulation of Hypothesis

Develop the right hypothesis by asking the right questions the experimental results are expected to answer. To show conclusively that component A has a much higher reliability than component B has solved nothing if component A cannot be mass produced.

I. Type of Measurement

The type of measurement to be used should be considered for the sake of efficiency. Variable type data can vary from minus infinity to plus infinity and furnish the maximum information per observation. Attribute data are "success" "failure" type data and furnish the least information per observation. From this it is clear that variable type data should be used wherever possible in factorial experiments; care should be exercised, however, in using variable data to determine reliability (see below).

J. Choice of Experimental Units

a. Definition of Experimental Unit

An experimental unit (test specimen) is the smallest sub-division of the experimental material that can receive different treatments.

b. Size of experimental unit

Sufficient homogeneous or uniform material should be available to conduct a complete set of treatment combinations (required by the experimental design) during a single period of time (such as a day) by a single instrument condition (such as calibration) and by a single operator or group of operators. Material produced during a particular period of time by a single process and by a single manufacturer can be considered homogeneous.

c. Representative nature of experimental units

The experimental units used should not differ in any important respect from the best known (parts) design to which the conclusions are to apply. If design changes are made on the basis of experimental results, the items used to obtain the results are, of course, not representative of the modified design.

d. Independence of Experimental Unit

Experimental units should respond independently of one another. Obtaining a failure on one should not affect any of the others. Using a separate item for each treatment combination will usually assure independence.

K. Choice of Treatments

Treatments are chosen to give as direct an indication as possible of the functioning characteristics of the components and to include as many as possible of the environmental conditions expected in use. This is

an engineering decision that must be based on good judgement and intimate knowledge of the purpose of the experiment.

L. Sequential Approach

The first experiment may have to be considered exploratory in nature. One or more ideas may be generated during the first experiment concerning parts design modifications or questions may be raised from the results of the first experiment concerning the exact effect of the environmental treatments. In either case additional experimentation would be required to:

a. Confirm the validity of the modified parts design.

b. Clarify the effects of the environments which produced the questionable results.

c. Include other treatments.

Committing oneself to a large experiment at the beginning of a new investigation may not be feasible. Small exploratory experiments may indicate a much more promising approach in a short time and with little cost. In this procedure the results of the first experiment are obtained and analyzed before the next experiment is designed.

## 2. DESIGN PHASE

A. Choice of design

The factorial design and its modifications described in this manual meet the requirements of environmental testing experiments better than any other known design. The advantages of the recommended factorial designs for environmental testing are as follows:

a. Simple to use and analyze.

b. No control groups are required.

c. The two levels of each treatment can be the presence and absence of the treatment, if desired. Alternatively, any two levels of the treatments can be used.

d. Each treatment effect can be determined independently of all the others. Unambiguous conclusions can be drawn about each treatment's effects.

e. Complex experiments involving a large number of treatments can be easily handled.

f. These are the only experimental designs with which the relationships among treatments can be measured. These designs can determine whether the effect of one treatment depends upon any of the others. These relationships are called interactions.

g. The probability of being right or wrong can be controlled.

h. When the number of treatments used becomes large (three or more), only a fraction (1/2, 1/4, 1/8, etc.) of the total number of combinations of treatments and levels need be used. These designs are called fractional factorials and optimum multifactorials.

i. A type of statistical analysis can be used that distinguishes between variations due to chance and variations having assignable causes.

j. More information can be obtained from a given number of test specimens than any other known procedure.

k. The effective sample size is increased by making it possible to use each observation (or measurement) for more than one purpose. In fact,

each treatment effect is determined as though the entire experiment is conducted to determine that particular treatment effect alone. As a result, the precision with which each treatment effect is determined can be based on the total number of test specimens used in the experiment.

B. Sample Size

In any experimental situation a reasonable balance must be established between using too few test specimens thus obtaining poor precision, and wasting time and material in attaining unnecessarily high precision by using too many test specimens. When there is a preassigned number of test specimens available, the question is whether it is worthwhile to do the experiment at all. If the number of test specimens available is flexible and adequate, the number required for a given precision or reliability can be calculated in advance. The minimum number of test specimens required in the optimized designs is only one more than the total number of treatments used. The more versatile factorial designs require at least 16 items for five through eight treatments and at least 32 items for nine through thirteen treatments. With twice these numbers of items, the latter designs can also measure interactions.

C. Orthogonality

The property of these designs, known as orthogonality, must be preserved in order to simplify the analysis and interpretation of the results. This can be done by keeping the number of observations per treatment combination equal and constant throughout the entire design. Orthogonality assures that all the environmental effects and their interrelationships can be independently estimated without entanglement.

D. Confounding

Confounding is the converse of orthogonality. It means confusing, entangling, or equating two or more factors or treatments so that their separate effects cannot be determined. For example, little can be concluded about the separate effects of the environmental treatments if all of the treatments are applied to each item. If a failure is obtained after an item has received two or more treatments, the cause of the failure is ambiguous; it could be the result of any of the following:

a. The last treatment.

b. The last two treatments.

c. All of the treatments.

d. Any of the other possible combinations.

The exact cause cannot be determined because the treatments are confounded. This type of confounding should be avoided.

E. Interactions

Interaction is said to be present when certain particular treatment combinations produce unusual results. This is the non-additive or unpredictable portion of the experiment; as such, interaction effects are considered discoveries by the U.S. Patent Office and as such are the only patentable portion of the experiment. When appreciable interaction effects are present, care must be taken in quoting main (average) effects. Any statement about the average effect of a treatment must specify the level of the interacting treatment associated with that average.

However, determination of interaction effects may be the most important information obtained from an experiment. It can explain what otherwise appear to be contradictions. This is the extra information furnished by factorials that cannot be obtained from other designs. Plans should be made to use factorials that can measure interaction effects if there is a possibility that they exist. Higher order interactions can be used as estimates of the error term when multiple replication is not used.

F. Replication

By replication is meant repetition. One complete replication consists of a single observation for each of the treatment combinations in the design. If the observations are performed in sets, so that a complete replication is done in a continuous period of time (such as a day), with a single measuring system (or instrument), by a single operator, the difference among replications can be used to determine whether the external experimental conditions have remained under control. Multiple replications are also used for the following purposes:

a. Increase the precision with which treatment effects are determined.

b. Furnish an independent measure of the error term.

c. As a basis for calculating the failure rate observed for each treatment combination in preparation for transforming attribute data to a continuous scale in analysis of variance procedures.

G. Blocking

In general, blocking means dividing the entire design into orthogonal sub-groups. This reduces the number of observations that need be taken in one continuous period of time and reduces the amount of homogenous material required in one batch. Differences among blocks due to uncontrolled changes with time and due to changes in material can be mathematically subtracted out of the system. That is, the object of blocking is to make it possible to conduct the experiment in reasonably small portions. Plans should be made to block any large experiment or any experiment expected to extend over a long period of time. Taking observations in complete replication sets is one form of blocking.

H. Randomization

Randomization can be accomplished by means of a table of random numbers or by drawing well shuffled numbered cards from a hat. The important characteristic of randomization is that it be an objective impersonal procedure. Proper randomization is determined by examining the procedure producing it, not by examining the results. To randomize does not mean to arrange in an order that looks haphazard. The object of randomization is to permit the laws of chance (probability) to have free play. Proper randomization is the most important requirement for a good experiment because it:

a. Prevents biased results of all kinds due to such things as, human prejudice, weather cycles, trends in time, heterogeneity of experimental material, etc.

b. Removes systematic error.

c. Relieves the experimenter of the responsibility of choosing which item of test or which test to conduct. Each item or test is equally likely to be chosen. In this sense the experiment is "fair" and unbiased.

d. Assures the validity of statistical techniques, such as the analysis of variance and associated tests of significance which depend for their validity upon the laws of probability. However, the use of randomization can be abused. Randomization should not be used to conceal large variations. This drastically reduces the sensitivity of the experiment to detect small differences. All variables known to have, or suspected of having, significant effects on the outcome of an experiment must be either controlled or designed into the experiment. The use of randomization should be considered as an expression of ignorance and used only to remove the effects of small variations after every other source of variation has been included in the design, or controlled. Only the use of good engineering judgment and a knowledge of the system can determine how, when, and where to use randomization.

## 3. ANALYSIS PHASE

### A. Statistical Significance

The word significance has a special technical meaning in statistics. Its meaning must be understood in order statistically to analyze and interpret experimental results. One of the most important contributions of statistics is that it has established a means of distinguishing between chance variations and assignable causes. When the observed differences are due to chance variations, these differences are said to be non-significant. This means that the observed results originated from the same source (population). When the observed differences have assignable causes they are said to be significantly different.

This means that the observed results have originated from different sources (populations). In a well planned experiment these sources can be identified. In the case of a non-significant difference, changing the treatment from its lower level to its higher level has not caused a detectable difference. In the case of a significant difference, changing the treatment from its lower level to its higher level has caused a detectable difference.

B. Interpretation

In a good experiment each treatment effect should have a unique interpretation. If two or more interpretations are possible, additional work is required to clarify the ambiguities. One of the most important requirements of a good experimental design is that the conclusions be unambiguous. Fortunately the factorial designs are very helpful in avoiding ambiguity. To conclude that an effect is not significant is not the same as saying that the effect does not exist. We can only say that there is insufficient data to detect the effect. However, if the conclusions are that the effects are significant (from the test of significance), we can be assured that the effect is real to the extent of the confidence level associated with the test of significance. Further advantages of factorial designs are as follows:

a. The range of validity of the conclusions concerning the average (main) effects is extended by the inclusion of more than one variable in the experiment.

b. Physical interpretation of interactions explain and clarify underlying mechanisms and relationships.

C. Qualitative Data (Success or Failure)

When only one observation is taken for each treatment combination, analysis of the results from the factorial designs described in this manual is made very simple by using the tables of minimum contrasts in Appendix 3A. These tables are based on the binomial distribution. The test of significance that uses the values in these tables is known as Fisher's Exact Method for 2 x 2 Contingency Tables. This test is valid even for small sample sizes and will determine not only the main effects but also the two-factor interaction effects when the proper designs are used (see example described below.) When multiple (but equal number of) observations are taken for each treatment combination, the Fisher method can still be used. However, an alternate method which is slightly more efficient, but which requires more calculating can also be used. This method transforms the qualitative data to a continuous scale through the use of the arc sine of the proportion or percentage of failures found for each treatment combination. The transformed data can be analyzed by the usual analysis of variance techniques. The tests of significance and their interpretations are both made using the transformed data. If the arc sine transformation is considered desirable, it is suggested that a statistician be consulted to conduct the analysis of variance.

D. Quantitative Data

For quantitative data (such as g - values, voltages, or time) the usual analysis of variance can be conducted on the observed data provided the

variances are homogeneous throughout the design. Since this procedure is somewhat involved, lengthy to describe, and is adequately covered in the literature (see ref. 18 and 19), an attempt will not be made to include the analysis of variance techniques in this manual. It is suggested that a statistician be consulted for this analysis.

## IV PLANNING TEST PROGRAMS [a]

### 1. STATEMENT OF THE PROBLEM

A. Identify the new and important problem area.

B. Outline the specific problem within current limitations.

C. Define exact scope of the test program.

D. Determine relationship of the particular problem to the whole research or development program.

### 2. BACKGROUND INFORMATION

A. Investigate all available sources of information.

B. Tabulate data pertinent to planning new program.

### 3. METHODS DEVELOPMENT

A. Hold a conference of all parties concerned.

a. State the propositions to be proved.

b. Agree on magnitude of differences considered worthwhile.

c. Outline the possible alternative outcomes.

d. Choose the factors to be studied.

e. Determine the practical range of these factors and the specific levels at which tests will be made.

f. Choose the end measurements which are to be made.

g. Consider the effect of sampling variability and of precision of test methods.

h. Consider possible inter-relationships (or "interactions") of the factors.

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a This outline was received in a private communication from Mr. Charles Bicking, Office, Chief of Ordnance.

j. Determine limitations of time, cost, materials, manpower, instrumentation and other facilities and of extraneous conditions, such as weather.

k. Consider human relations angles of the program.

4. DESIGN OF EXPERIMENT

A. Design the program in preliminary form.

a. Prepare a systematic and inclusive schedule.

b. Provide for step-wise performance or adaptation of schedule if necessary.

c. Eliminate effect of variables not under study by controlling, balancing, or randomizing them.

d. Minimize the number of experimental runs.

e. Choose the method of statistical analysis.

f. Arrange for orderly accumulation of data.

B. Review the design with all concerned.

a. Adjust the program in line with comments.

b. Spell out the steps to be followed in unmistakable terms.

5. DATA COLLECTION

A. Develop methods, materials, and equipment.

B. Apply the methods or techniques.

C. Attend to and check details; modify methods if necessary.

D. Record any modifications of program design.

E. Take precautions in collection of data.

F. Record progress of the program.

6. ANALYSIS OF DATA

A. Reduce recorded data, if necessary, to numerical form.

B. Apply proper mathematical statistical techniques.

7. INTERPRETATION OF RESULTS

A. Consider all the observed data.

B. Confine conclusions to strict deductions from the evidence at hand.

C. Test questions suggested by the data by independent experiments.

D. Arrive at conclusions as to the technical meaning of results as well as their statistical significance.

E. Point out implications of the findings for application and for further work.

F. Account for any limitations imposed by the methods used.

G. State results in terms of verifiable probabilities.

## V COMPONENT RELIABILITY

### 1. INTRODUCTION

Reliability is the probability of the successful performance of a specified characteristic:

A. Under a specified condition or set of conditions,

B. For a specified length of time,

C. After a specified period of storage.

The "length of time" requirement can usually be included as part of the specified conditions.

The storage requirement has to do with age or storage life. This requirement involves the use of life-testing techniques. To be useful these techniques must be able to predict storage life from short-term (a few days or weeks) accelerated laboratory tests. In order for these predictions to be valid, the laboratory test results must be correlated with storage life results by actual long-term storage tests. At present this kind of information is not available.

Life-testing techniques can also be used to determine the reliability of an item with respect to environments whose level of severity can only be increased by increasing the length of time of exposure. To do this, however, requires the establishment of a minimum length of exposure time for successful functioning. The difficulty here is that component reliabilities established

by tests of increased severity, in which time is the variable, are not comparable with component reliabilities established by tests of increased severity in which the level of the environment is the variable.

These two kinds of component reliability cannot both be used in the same system to calculate the reliability of that system and have the result meaningful.

The Ideal Test Condition

The ideal condition for determining reliability is that condition found in tensile or compression testing. That is, the following conditions exist which make possible the most efficient determination of the ultimate strength:

1. The observed results are in the form of variable-type data.

2. The severity of the applied stress can be easily increased until failure occurs.

3. The magnitude of the applied stress is continuously available so that the load at the point of failure can be directly observed.

4. The occurrence of failure can be detected by inspection.

5. The average of the observed results is an unbiased estimate of the ultimate strength.

With this combination of conditions and information the greatest precision and accuracy can be obtained with the smallest sample size. Aside from being convenient and easy to conduct, this method gives a direct measure

of the ultimate strength and therefore the margin of safety from which reliability-in-use can be calculated.

The efficiency of variable-type data can be fully exploited here since each observed value is at the point of failure. This is the value of the stress that the 50% point on the cumulative frequency curve estimates in the indirect methods described in Section XI 3: Tests of Increased Severity. This average value at the point of failure in the ideal test and the 50% point in the indirect methods is important since it is the only unbiased measure of the ultimate strength, the margin of safety, and the reliability-in-use.

In all reliability testing the characteristics of the ideal testing condition should be kept in mind as a guide in more complicated situations where indirect methods must be used. In this way the disadvantages of testing without failure and collecting variable-type data at a single stress level can be seen in better perspective. For example, measuring the resistance of the circuits of several similar test specimens at a single voltage cannot measure reliability. This procedure gives only one point on the ($I^2R$)-strength curve. Where the point at which 50% of the items fail or what the margin of safety is cannot be determined using a single voltage value. Calculating the probability of obtaining resistance values outside given limits with information of this kind assumes that the margin of safety is equal to zero.

## 2. COMPONENT TESTING

Component testing can be accomplished in either of two ways, controlled laboratory tests, or flight tests. Each of these has its advantages and disadvantages:

A. Advantages of controlled laboratory testing are:

a. Cost - This is the cheapest method both from the cost of test facilities and from the cost of test specimens for determining reliability with respect to separate environments during the development phase.

b. Information. - Complete information can be obtained since the test specimens are available for complete instrumentation and visual examination.

c. Controlled conditions. - Each test specimen can be subjected to precisely the desired treatment.

d. Results - Unbiased estimates of reliability can be obtained by testing to failure in a predetermined manner so that the average reliability-in-use can be predicted from the test results.

e. Efficiency - Tests of increased severity can be used to demonstrate high reliability with small sample sizes.

f. System reliability prediction. - Information can be furnished on a current basis during the development phase of an item which can be used as a guide during development and which can be used to predict the expected system reliability.

B. Disadvantages of controlled laboratory testing are:

a. Facility limitations - Environments must be applied in sequence instead of simultaneously as experienced in use.

b. System reliability prediction - System reliabilities are predicted with incomplete information. The extent of component interaction and independence is not known. The degree to which the human factor, during assembly, reduces reliability is also not known.

c. Sample size - Larger sample sizes are required for laboratory testing of components under use - conditions than for testing systems in flight to demonstrate a given systems reliability.

C. Advantages of flight tests are:

a. Environment - Test specimens are subjected to actual use conditions; all of the environments are applied simultaneously and at the correct level of intensity and duration.

b. Verification - Flight testing is a means of verifying all of the predictions based on component values and other information.

D. Disadvantages of flight tests are:

a. Observation - The tested specimens are not available for examination.

b. <u>Measuring system</u> - Measurement by telemetry is not precise or reliable.

c. <u>Cost</u> - The cost of flying a test vehicle is excessive.

d. <u>Storage characteristics</u> - Storage characteristics cannot be determined by flight tests.

E. From the above description of the relative merits of laboratory testing and flight testing the following conclusions can be drawn:

a. Laboratory testing furnishes the most information.

b. Efforts to improve testing methods should be directed to improving laboratory methods.

## 3. CALCULATION

A. <u>Tests of increased severity</u>

$$R = 1 - P$$

Where:

R = Mean reliability over the range of in-use conditions

P = Probability of failure-in-use measured by the overlapping areas under the stress and strength curves (see page 112 for curves) and which can be found by entering a table of areas under the standard normal curve (Appendix G) with the following normal deviate:

$$Z = \frac{(X_1 - X_2) - (M_1 - M_2)}{\sqrt{\sigma_1^2 + \sigma_2^2}}$$

A failure can occur only when:

$$X_1 \geq X_2$$

Therefore the normal deviate becomes:

$$Z \geq \frac{M_2 - M_1}{\sqrt{\sigma_1^2 + \sigma_2^2}}$$

$X_1$ = any stress value

$X_2$ = any strength value

$M_1$ = True (but unknown) mean of the stress distribution

$M_2$ = True (but unknown) mean of the strength (failure) distribution

$\sigma_1^2$ = True (but unknown) variance of the stress distribution

$\sigma_2^2$ = True (but unknown) variance of the strength (failure) distribution.

The above values can be estimated from sample results as follows:

$$\hat{R} = 1 - \hat{P}$$

Where:

$\hat{R}$ = An estimate of the true reliability (R)

$\hat{P}$ = An estimate of the true probability (P) of failure-in-use which can be found by entering a table of areas under the standard normal curve (appendix 3G) with the following calculated value:

$$T \geq \frac{|\bar{X}_2 - \bar{X}_1|}{\sqrt{s_1^2 + s_2^2}}$$

Where:

T = The normal deviate listed in appendix 3G for each $\hat{P}$ value.

$\overline{X}_1$ = Average in-use condition (in terms of the environmental stress level) established by experience or actual measurement of the handling, storage, or flight conditions.

$\overline{X}_2$ = Average stress at the observed point of failure, or the stress at the point 50-percent point on the failure rate curve established by a test of increased failure when the occurrence of a failure cannot be determined by inspection.

$\left|\overline{X}_1 - \overline{X}_2\right|$ = Absolute difference between the two averages without regard to the algebraic sign, which is a measure of the margin of safety.

$s_1$ = Standard deviation of the in-use conditions (in terms of the environmental stress level) established by actual measurement of handling, storage, and flight conditions.

$s_2$ = Standard deviation of the stress at the observed point of failure or standard deviation of the failure rate curve (in terms of the environmental stress level) established by a Bruceton-type test of increased severity when the environmental stress levels at the point of failure cannot be observed directly.

B. Life tests. When time is the variable rather than the level of the environment and the length of time ($t_i$) is observed for each failure and the test terminated at the exact time ($t_a$) of the last failure:

$$\hat{R} = e^{-\ t/m}$$

Where:

$\hat{R}$ = Sample reliability under the test condition as the probability of no failures in time (t).

$e = 2.7183$

$$m = \frac{t_1 + t_2 + \text{---} + t_a + (n-a)t_a}{a} = \frac{h}{a} = \text{Time per failure}$$

$t_i$ = Time to failure of individual components.

h = Time during which "a" failures occurred.

a = Number of components that failed in time (h).

n = Number of components tested.

t = Required failure-free time.

This formula is not applicable during infant mortality or wear-out periods.

C. Binomial-type data (binomial distribution). The following technique is applicable when these conditions pertain:

a. The lot or population represented by the sample is very large or infinite.

b. The sample size is less than 10 percent of the lot size.

c. Each test specimen can fail in only one way.

$$\hat{R} = \frac{k}{n}$$

Where:

$\hat{R}$ = Sample reliability. The probability of success under the test condition.

k = Number of successes.

n = Number of test specimens or number of trials.

D. Variable-type data. By definition reliability is the probability that an item will perform successfully under a specified set of conditions which can include environments, or time, or both. If it does not perform successfully, the item fails. By definition there are only

two possible outcomes; success or failure. There are no other alternatives in reliability testing.* Half of the test specimens used can perform successfully, but any particular specimen cannot "only half succeed" or "succeed half way." Just as when tossing coins, heads can occur on half of the coins, but on any one coin there cannot be a "half of a head."

By definition then, there are only two possible outcomes in reliability testing. Data of this type — called attribute data — have only discrete values — are obtained by a counting process.

Variable data, as the name implies, can vary on a continuous scale- from zero to infinity. This type of data is obtained by a measuring process.

Text books on the subject of statistics state that variable data are more efficient than attribute data because more information is obtained per observation. But this advantage of variable data does not pertain to reliability testing except in the direct method where the observed values estimate the ultimate strength. If variable data be used for reliability testing in other cases, they can only be for the purpose of measuring a characteristic of the test specimen to determine the number of successes or failures. In this application, the "text book" efficiency of variable data is lost — the results obtained in this manner can be used in the formulas given above for calculating reliability.

The probability of a measured value's exceeding a given limit obtained from the average and standard deviation of a dependent variable (such as, ohms

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*Reliability testing means the stressing of a test specimen by an environment or time, to measure the margin of safety.

resistance, percent elongation, timing accuracy or hardness) at ambient static conditions does not measure reliability. There can never be a reliability with respect to a dependent variable. Dependent variables are properties of an item or material the same as reliability is a property.

An item or material cannot be stressed by, or subjected to, its own properties. In failure testing an item's properties can be used to determine only the number of successes or failures when the item or material is being stressed by or subjected to an independent variable such as, E.M.F. in volts, tensile load in pounds, or vibration in g's. In cases of this kind the observed proportion of successes measures the reliability with respect to the independent variable. The average and standard deviation of dependent variables at ambient static conditions can measure only the quality of material, the quality of the manufacturing process, or the effect of handling or storage on the measured properties - not reliability. Although there can be reliability with respect to storage conditions, this reliability must be measured using time as one of the independent variables in distributions such as the Poisson. Reliabilities of this kind are stated in terms of the probability of no failures in a given length of time, not as the probability of a value exceeding a given limit.

## VI SYSTEMS RELIABILITY

### 1. INTRODUCTION

The advantages and disadvantages of laboratory and flight tests described above for components also pertain to testing complete systems; however, testing complete systems cannot be used as a prediction procedure during R and D since it is testing after the fact. In addition, testing complete systems is expensive and difficult even in the laboratory. As a result, it is concluded that component testing must be done during the development phase in order to obtain the required detailed information when it is needed. In so doing, all of the shortcomings of the several methods of reliability testing which constitute the state of the art, culminate in the estimate of system reliability. Some of the errors are compensatory, as:

A. Errors that underestimate reliability.

a. Testing without failure.

b. Estimating reliability under extreme use conditions only.

B. Errors that overestimate reliability.

a. Applying environments in sequence instead of simultaneously.

b. Estimating reliability with respect to only one environment.

c. Calculating system reliabilities on the assumption that components function and react to environments independently.

To what extent these errors compensate one another is not known.

The one big advantage of testing complete systems under use conditions after the R and D phase, such as flight tests during stockpile testing, is the higher reliability that can be demonstrated in series systems with a given sample size. For example, if 15 adaption kits are flight tested without a failure, this demonstrates a system reliability of at least 85 percent at the 90 percent (one-sided) confidence level. On the assumption that the adaption kit is made up of 5 major components in series, it would be necessary that 70 of each of the 5 major components be tested without a failure to demonstrate an equivalent system reliability calculated from the components. In addition the difficulty of how to apply the environments to the components in the laboratory would be encountered.

## 2. CALCULATION

Obtaining point estimates of system reliabilities from component reliabilities requires the development of a probability equation based on the circuitry of the system and the laws of probability. Since this procedure is treated extensively in readily available literature, such as reference 15, it has not been included here.

When each test specimen (such as a system) can fail in more than one way, the Poisson distribution can be used as follows (ref. 14):

$$\hat{R} = e^{-\bar{X}}$$

Where:

$\hat{R}$ = Sample reliability under the test condition as the probability of no failures.

$e = 2.7183$

$\bar{X} = d/n$ the average number of failures.

$d$ = Number of failures.

$n$ = Number of test specimens.

## 3. SAFETY

Safety can be defined as the probability of a catastrophic failure. A measure of this characteristic can be obtained from the techniques described herein for reliability, with slight modification. For the determination of safety, only catastrophic failures can be counted and used. In this case, of course, the objective is to calculate the probability of a failure-in-use - not its complement.

The relation between safety and reliability can best be seen from the following diagram:

PROBABILITIES

Safe + Unsafe = 1

GOOD + DUD + PREMATURE + LATE = 1

Reliable + Unreliable = 1

## VII RELIABILITY CONFIDENCE INTERVALS

### 1. Introduction

#### A. Definition

A confidence interval is a range of values within which the true population parameter—such as reliability—is expected to lie. The confidence level associated with this interval is a probability statement expressing the proportion of the time the true value is expected to be within the interval or, is the probability of being right in predicting that the true value will be within the calculated interval.

#### B. Best Estimate

In order to calculate a valid confidence interval the "best point estimate" of the true population parameter must first be obtained. Whether an estimator is the "best" depends on how it is determined and how it is used. On the assumption that the estimator used is the correct one for the intended purpose, it is considered an unbiased point estimate if the mean of all the possible sample values equals the true population parameter. This also means that the estimator is accurate. In addition to being unbiased the estimator used should also be efficient. That is, the unbiased estimator chosen for use should have the minimum variance of all the possible unbiased estimators that could be used. This means that the estimator should be precise. An estimator that is both unbiased (accurate) and efficient (precise) is said to give the "best estimate" of the true population parameter. It is this kind of estimator that is required to calculate valid confidence intervals or confidence limits.

In most engineering work the arithmetic average of variable data is the "best estimate" of the true mean of the population represented by the data. That is, the arithmetic mean meets the requirements of a "best estimate" since:

(1) The mean of all the possible sample (arithmetic) averages equals the true mean and is therefore unbiased.

(2) The variance of the arithmetic mean is smaller than those of other possible estimators, such as the median, mode, or mid-range.

What has been said above for variable data is also true for attribute data. This means that in both cases the "best estimate" of the true population mean is the observed or sample average.

In reliability testing the "best estimate" is the <u>observed</u> proportion of successes or failures. Anything else cannot qualify as a "best estimate". For example, the various attempts that have been made to avoid the dilemma created by obtaining no failures in a test sample include the use of the lower limit of the 50% confidence level as the "best estimate." This value cannot qualify as a "best estimate" since:

(1) The lower limit of a confidence interval can <u>rarely</u> be an unbiased estimate of the "true value" the interval is expected to encompass; (2) <u>any</u> lower confidence limit which equals or exceeds 50% has a larger variance than the observed value.

In summary, then, the <u>**observed**</u> sample average (or proportion) is the only value around which a confidence interval should be placed.

## 2. CALCULATION FOR COMPONENTS

### A. For tests of increased severity

Calculate the limits of the confidence interval for $\bar{X}_2$ as follows (ref. 3):

$$\bar{X}_2 \pm \frac{ts_2}{\sqrt{n_2}}$$

Where:

$\bar{X}_2$ = Average stress of the failure distribution, or the stress at the 50 percent point on the failure rate curve generated by a test of increased severity.

$t$ = Coefficient by which the standard deviation is multiplied to control the confidence level.

$s_2$ = Standard deviation of the failure rate curve (generated by a test of increased severity) in terms of the stress.

$n_2$ = Sample size used to obtain $\bar{X}_2$.

These adjusted values of $\bar{X}_2$ are then substituted for $\bar{X}_2$ in the above formula for reliability from tests of increased severity and the reliability recalculated for both limits. These recalculated values can be taken as the upper and lower limits of the confidence interval for the average (point estimate) reliability-in-use.

### B. Life tests

When the length of time ($t_i$) is observed for each failure and the test terminated at the exact time ($t_a$) of the last failure.

$$e^{-Ut/2am} \leq R \leq e^{-Lt/2am}$$

Where:

$R$ = True Reliability

$e$ = 2.7183

$U$ = Upper percentage point of the chi-square distribution obtained from Appendix 3c for half alpha and 2a degrees of freedom.

$L$ = Lower percentage point of the chi-square distribution obtained from Appendix 3c for one minus half alpha and 2a degrees of freedom

$t$ = Required failure-free time.

$$m = \frac{t_1 + t_2 + t_3 + --- + t_a + (n-a)t_a}{a}$$

$n$ = Number of components tested.

C. <u>Attribute-type data</u>

a. <u>Binomial distribution</u>:

The following technique is applicable when each test specimen can fail in only one way and when <u>any</u> one of these conditions pertain (page 120 ref. 21):

(1) The lot or population represented by the sample is very large or infinite.

(2) The sample size is less than 10% of the lot size.

(3) Sampling is done <u>with</u> replacement.

<u>Lower Limit</u> (page 373 ref. 23):

$$R_l = \frac{a}{a + (n-a+1)\ F_l}$$

Where:

$p_1$ = Lower limit of the confidence interval for defects or failures. One minus this proportion is the upper limit of the confidence interval for successes.

a = Number of defects or failures.

n = Sample size or the total number of trials.

$F_1$ = Upper percentage point from a table of the F-distribution.

Enter the F-table in Appendix 3E with the following values:

$$V_1 = 2\ (n-a+1)$$

$$V_2 = 2a$$

Upper Limit:

$$p_2 = \frac{(a+1)\ F_2}{(n-a) + (a+1)F_2}$$

Where:

$p_2$ = Upper limit of the confidence interval for defects or failures. One minus this proportion is the lower limit of the confidence interval for successes.

a = Number of defects or failures.

n = Sample size or total number of trials.

$F_2$ = Upper percentage point from a table of the F-distribution.

Enter the F-table in Appendix 3E with the following values:

$V_1 = 2\ (a+1)$

$V_2 = 2\ (n-a)$

These limits can also be obtained directly from the tables in Appendix 3B.

b. Hypergeometric distribution:

This distribution is applicable when each test specimen can fail in only one way and when all of the following conditions pertain (page 120 ref. 21):

(1) The lot size is small (finite) but can be considered the population and not a random sample of a much larger volume of material.

(2) Sampling is done without replacement.

(3) The sample size exceeds 10 percent of the lot size.

The usual formula for the hypergeometric distribution calculates the probability that a given sample will contain exactly "x" defectives. This calculation is based on the size of the lot (population) when the lot fraction defective is known. However, the converse of this is usually required. Thus, knowing the observed fraction defective in the sample, the upper confidence bound of the fraction defective of the lot is required. Tables based on the hypergeometric distribution have been prepared from which the desired information can be obtained directly (see Appendix 3H). In addition, the upper confidence bound of the fraction defective of a finite lot can be estimated by multiplying the upper confidence bound of the fraction defective of an infinite lot by the following factor:

$$\sqrt{\frac{N-n}{N-1}} \qquad \text{(see page 121 ref. 21)}$$

Where:

N = The lot size.

n = The sample size required to calculate a given upper confidence bound of the fraction defective in an infinite lot, using the binomial distribution.

Care should be taken in the use of the hypergeometric distribution. The upper confidence limit of the fraction defective of a finite lot is less than that for an infinite population when each is predicted from equivalent or identical samples. This comparison is shown in the following table for samples containing no defectives and for the 90 percent one-sided confidence level:

| Sample Size | Lot Size | Proportion Defective: Hypergeometric* | Proportion Defective: Binomial** |
|---|---|---|---|
| 2 | 40 | .675 | .684 |
| 4 | | .400 | .438 |
| 8 | | .225 | .250 |
| 16 | | .100 | .134 |
| 32 | | .025 | .070 |
| 5 | 100 | .36 | .369 |
| 10 | | .19 | .206 |
| 20 | | .09 | .109 |
| 40 | | .04 | .056 |
| 80 | | .01 | .028 |

* Finite lot size taken as the population.

** Infinite population.

| Sample Size | Lot Size | Proportion Defective Hypergeometric* | Proportion Defective Binomial** |
|---|---|---|---|
| 10 | 200 | .20 | .206 |
| 20 | | .10 | .109 |
| 40 | | .05 | .056 |
| 80 | | .02 | .028 |
| 160 | | .005 | .014 |

* Finite lot size taken as the population.

** Infinite population.

The hypergeometric distribution is useful in acceptance testing where decisions must be made about specific lots of finite size. However, it should not be used in the development and stockpile phases of a missile life cycle. In the development phase, decisions must be made about lots of indefinite size. In the stockpile phase, decisions cannot be limited to the small quantity in storage; at this stage of the life cycle, there is interest, also, in what the small stored quantity represents. That is, small quantities are placed in the stockpile to further the state of the art, not to win a war. For this purpose decisions must be made about the larger indefinite quantities represented by the stockpile. Predictions in this case require the use of the binomial rather than the hypergeometric distribution.

## 3. CALCULATION FOR SYSTEMS

### A. Poisson Distribution

When each test specimen (such as a system) can fail in more than one way (ref. 14):

$$e^{-U/n} \leq R \leq e^{-L/n}$$

Where:

R = True reliability under the test condition, as the probability of zero failures.

e = 2.7183

U = Upper confidence limit of "c" (the counted number of failures) obtained from Appendix 3D.

L = Lower confidence limit of "c" (the counted number of failures) obtained from Appendix 3D.

n = Number of test specimens (systems) used.

B. Other methods

When the system reliability is calculated from component reliabilities, the lower bound of the confidence interval can be obtained by either of two methods recently developed at Picatinny Arsenal: One based on the propagation of errors method to calculate the variance (ref. 16) and one based on the Monte Carlo method of sampling (ref. 17). Both of these procedures are lengthy and involved. An electronic computer may be needed to make the calculations required by either of these methods.

However, before calculating a confidence limit for a system reliability the following should be considered:

a. Confidence limits based on biased estimates are also biased. The confidence level associated with such limits is not valid. Reliability values obtained under conditions that produce less than 50% failures are biased estimates of the true or ultimate reliability.

b. The magnitude of the differences between the nominal values (point estimate) of high reliabilities and the lower confidence limits based on their variances is always very small and of little practical importance.

c. If the lower confidence limit of a system reliability is to be determined, the method given above for the binomial distribution for components can be used. In this case the number of failures (a) equals n $(1-\hat{R})$ where $(\hat{R})$ is the system sample reliability and (n) is the average sample size which equals the sum of the component sample sizes used to determine $(\hat{R})$ divided by the number of component types (or kinds) that comprise the system. This procedure is quick and easy to calculate and is sufficiently accurate for most purposes.

d. Because of the efficiency of testing entire systems as a unit, pointed out above (Section VIII Systems Reliability), every effort should be made to test in this manner. This procedure also avoids the difficult problem of calculating the lower confidence limit of a system reliability derived from component reliabilities. Since the system is the experimental unit (or test specimen) in this case, the confidence limits can be easily calculated by either of the following methods given above:

(1) The binomial distribution when the system can fail in only one way.

(2) The Poisson distribution when the system can fail in more than one way.

The one exception to the rule of testing systems as a unit is in the development phase where a prediction procedure is required.

## VIII SAMPLE SIZE

### 1. INTRODUCTION

Because of economic considerations, the question of how many specimens to test (or how large a sample size to use) is always given a prominent part in planning any testing program. It is the question most often asked by engineers concerning testing programs. To answer this question from only the economic point of view is not enough. The cheapest testing program is none at all! Of course, if no testing is done there is no verification that the newly developed item is useable and no information concerning the condition of a stored item.

Before the question of sample size can be answered, the following related points must be taken into consideration:

A. The notion that reliability is related to the number of specimens tested must be discarded. Only the precision with which the reliability is determined is related to the sample size.

B. There is no one single sample size that is applicable to all reliability testing programs. Each program must be considered individually.

C. A valid sample size cannot be stated without first knowing the purpose of the testing program. It is very easy to get the right answer to the wrong problem.

The purpose of planning the sample size prior to data collection is to obtain essential information with minimum cost, effort, and material, essential information being defined as the minimum information required such that additional data will not change the conclusions. To accomplish this the

following design of experiment techniques must be considered, since the question of sample size cannot be answered out of this context:

## 2. DESIGN OF EXPERIMENT TECHNIQUES IN SAMPLE SIZE DETERMINATION

### A. Purpose and Objectives:

The purpose of any testing program is to verify the hypothesis that objectives (including requirements) have been achieved or maintained. To do so in any valid quantitative way, the characteristics of the sampling and testing procedures must be adequate, and to do so with the minimum sample size, these procedures must be highly efficient. By efficient is meant maximum precision with minimum sample size.

### B. Precision of Sampling Procedures

In all practical testing programs, especially those in which the testing is destructive, something less than all of the existing items should be tested and from this an inference made about the remaining (usually larger) portion of items. To have these inferences valid the sample must "represent" the remaining portion of the lot or population. If the lot is homogeneous, a representative sample can be obtained by random selection. That is, each individual item in the lot must have equal chance of being selected. If the lot is not homogeneous but stratified in some manner according to geographical location, weapon, or manufacturing process, then the sampling plan must be designed to cope with this characteristic of the lot. If the strata are only few in number, then an equal number of randomly selected specimens should be selected from each stratum. The number selected should be apportioned according to the size or importance of each stratum. If the number of strata is large, then specimens should be taken from only a part of the strata. If all

strata are equivalent, then a sample of the total number of strata should be randomly selected before the specimens within them are randomly selected. If all of the strata are not equivalent, then the most important or largest strata should be used. In any case, the actual selection of strata or specimens must be done in a random manner either by physical mixing and selection, or by numbering and determining which numbers to select by means of a table of random numbers.

It is important that the sample be stratified correctly to parallel that of the lot. It is only in this way that the heterogeneity of the sample can be kept to a minimum. Any increase in the heterogeneity of the material due to sampling, results in an inflation of the overall variation as measured by the standard deviation of the testing method. As shown below, the magnitude of the standard deviation is of prime importance in calculating sample size.

C. Precision of Testing Method

The testing method is in reality a measuring system or device. It "measures" the characteristic of the item being used as a basis for evaluation and decision. As any measuring device, the testing method must be precise and accurate. By precise is meant that characteristic of the method that produces estimates (numerical results) from repeated trials that are close together when in fact there has been little or no variation in the system. Methods which produce estimates close together and do not reflect variations that actually occur in the system are called insensitive rather than precise methods. Obviously this type of method is to be avoided.

It is important to have available the most precise methods possible, since, as can be seen below from the formulas, the sample size varies directly as the square of the standard deviation. The only way precise methods can be made available is **via** a continuous program of methods development.

D. <u>Decision Errors</u>

Because all testing is done on a sample basis, decisions (inferences) must be made about the lot based on the information gained from the sample. This in reality is a form of prediction. We all know that predictions cannot be made with certainty. However, there are only two kinds of error that can be committed in drawing inferences about the lot:

a. Type I error is rejecting good material.

b. Type II error is accepting poor material. It is desirable to keep both of these errors small. Their magnitude can be controlled by the number of specimens (sample size) tested in any given situation, as shown below. In practice, the magnitude of these errors **<u>chosen</u> is** based on the consequences of being wrong. (For example, the consequences of rejecting good material (Type I error) can cost only dollars, but the consequences of accepting poor material (Type II error) can cost lives and lose wars.) Then, the sample size required to maintain both errors at the selected levels is calculated.

E. <u>The Difference that Must be Detected</u>

In a testing program of any kind a decision must be made about at least one of the following requirements before anything can be said about sample size:

a. The maximum confidence interval that can be tolerated for the particular purpose intended.

b. The minimum difference (between two values) necessary to be detected for the purpose intended.

These requirements can be established only through knowledge of the objectives and purposes of the system under consideration. Fortunately, this kind of information is usually well known to the engineer. Sample size varies inversely as the square of the difference to be detected. The sample size required to detect a difference of (d/2) is four times that required to detect a difference of (d).

F. Experimental Design

a. Multi-variable Experiments

If effect of more than one variable (such as effect of more than one environment) must be determined, experimental design is extremely important in keeping sample size to a minimum. (By experimental design is meant the pattern or combination of the variables used to collect data.) If these combinations are correctly chosen, efficiency of the experiment can be greatly enhanced. In fact, the efficiency is improved by a factor equal to the number of variables included in the design. For example, to obtain a given precision, a factorial design for three variables requires only one-third the number of test specimens required by the classical one-at-a-time procedure. Factorial design for seven variables requires only one-seventh the number of test specimens required by the classical one-at-a-time procedure. (A factorial design is an experimental one in which all possible combinations of the variable levels are included in the experiment.)

At least one test specimen is required for each combination used. When this number becomes large, only a part of the total number of combinations need be used in designs called fractional factorial designs. These fractional designs have the same high efficiency as the full factorial designs. These designs should be used to screen all of the variables of interest to find the most important ones - such as the most severe environment.

b. Test of Increased Severity

Because of the exploratory nature of this test, an overall sample size cannot be precisely predetermined. The number of test specimens required to obtain the first failure depends upon the magnitude of the existing safety margin and the magnitude of the increments of stress used. After the first failure is obtained, the effective sample size is equal to only one-half the total number of test specimens used in the Bruceton up-and-down and the Two-Stimuli methods. However, these methods are highly efficient. That is, high reliabilities (if they exist) can be demonstrated with small sample sizes. For example, a reliability of .995 at the 90% (one-sided) confidence level can be demonstrated with 40 to 50 items with these methods. Higher reliabilities would require no larger sample size. In addition, these methods make it possible to calculate the reliability under the use condition.

Without these methods the above reliability would require at least 500 items tested without a failure. The reliability demonstrated in this manner would be under the test condition only. It would not be possible to calculate the reliability under the use condition. To demonstrate higher reliabilities (if they exist) would require larger sample sizes.

c. Life Test

When time is the variable instead of the environment, as in storage during Stockpile programs, the Poisson distribution is applicable. In this case, the sample size required to demonstrate a given reliability is directly proportional to the ratio of the required shelf life to the length of storage at the time of testing. If this length of storage is short compared to the expected shelf life, very large sample sizes with very few failures are required to demonstrate a reliability above 0.90.

G. Confidence Intervals

A confidence interval is defined as that interval around a sample value (such as the average) in which we expect the true (population) value estimated by the sample to lie. The confidence level is a probability statement expressing the proportion of the time the true value can be expected to be within the stated interval. The confidence level is the complement of the Type I error. That is, one minus alpha equals the confidence level. Where alpha is the probability of being wrong (in error), the confidence level is the probability of being right in our predictions. These probabilities can be measured by the area under a frequency distribution curve, such as the normal curve. As a consequence, there are two ways in which an area equal to alpha can be cut off:

a. By cutting off an area equal to alpha all in one tail of the curve.

b. By cutting off an area equal to one half of alpha in both tails of the curve.

Either way, the confidence level is the same for a given alpha value. To distinguish between these two ways the first is called a "one-sided" or "one-tail" level, and the second way is called a "two-sided or "two-tail" level.

The one- and two-sided confidence levels have distinctly different uses:

a. If there is interest in only one confidence limit, the one-sided level should be used.

b. If there is interest in both confidence limits, the two-sided level should be used.

The decision concerning which type of confidence level and what magnitude of confidence level to use in any given situation must be made prior to obtaining the data. The type of level must be based on the need for one- or two-limit intervals, and the magnitude of level must be based on the consequences of being wrong. To make these decisions after seeing the data affects the value of the confidence level associated with a given confidence interval. Probability statements derived from a set of data are not applicable to that set of data. The fact that one-sided confidence levels for reliability are higher than two-sided levels is not a valid reason for choosing one-sided confidence levels.

With these considerations in mind, the sample size required for a given confidence interval can be calculated as shown below. Conversely, for a given sample size, the magnitude of the associated confidence interval can be calculated. However, for variable type data the standard deviation must be known.

### H. Testing Hypotheses

Tests of hypotheses are used to compare two or more values, such as reliability values. The purpose of tests of this kind is to determine whether observed differences are due to chance variations or whether they are due to assignable causes. This is important in decision making. To decide that the reliability value obtained during the second testing period is smaller than that obtained during the first testing period is very disconcerting if the value obtained in the third testing period is larger than the first reliability value obtained. This is especially disturbing if the decision has led to more testing or replacement of parts, but this is exactly what can happen if the observed differences are due to chance variations. Only through use of statistical tests of significance can this difficulty be avoided.

In hypotheses testing both the alpha (Type I) error and the beta (Type II) error should be controlled to prevent difficulties of the kind described above. The beta error is especially important in Ordnance work because of the consequences of being wrong. The only way that these errors can be controlled at predetermined values is to calculate the sample size required to do so in advance of data collection. Experience has shown that when these two kinds of errors are kept at 5% or below, the risk of making a wrong decision is sufficiently low for most purposes. To reduce these errors below 1% requires very large sample sizes.

### I. Other Considerations

For lots made up of discrete items from which only attribute (success or failure) data can be obtained the following additional considerations should be made:

a. Lot Size vs Sample Size

If the lot is finite in size and less than ten times the size of the sample selected then this fact must be taken into account. The action taken in this regard depends upon the purpose of the testing and the scope of the conclusions drawn as described below.

b. Disposition of Selected Specimens

If the testing done destroys the specimens selected or if the specimens are not returned to the lot for any other reason, this fact must be taken into account. Again the action taken in this regard depends upon the purpose of the testing and the scope of the conclusions drawn as described below.

c. Purpose of Testing

A decision should be made prior to data collection concerning the purpose of the testing. If the purpose is to draw a conclusion about only those items in a small (finite) lot and if both of the two above conditions pertain, then the sample size can be reduced slightly through use of the hypergeometric distribution. This distribution finds its most frequent use in acceptance testing where the purpose is to predict the expected fraction defective of a particular small lot of items. If such a lot is placed in stockpile, however, then the hypergeometric assumption is no longer applicable since the purpose of testing is now different. Small lots of material in the stockpile represent larger lots of indefinite size. The characteristics of this material

are studied and recorded for their value in future applications. That is, the purpose of testing is to draw inferences about the larger volume of material represented by the small lot on hand. In this latter case, only the binomial assumption concerning lots of infinite size is applicable.

3. Calculation

A. Sample size required for a given confidence interval

a. Variable data

$$n = \frac{(ts)^2}{d^2}$$

Where:

n = Sample size

t = Standard deviate associated with the alpha error used to control the confidence level.

s = Sample standard deviation.

d = Magnitude of the confidence interval in the same units as the standard deviation.

b. Attribute Data

(1) Binomial Distribution

There is no easy, practical way **accurately to** calculate the sample size required for attribute data. The accurate methods are difficult to calculate and the simple, easy methods are not accurate. The most practical method is to refer to one of the existing tables for binomial confidence intervals to find the sample size required for a given interval. Tables useful for this purpose are:

One-Sided Limits:

Appendix 3B

Two-Sided Limits:

Appendix 3B

(2) Hypergeometric Distribution

As with the binomial distribution, there is no easy, direct way to calculate the sample size for the hypergeometric distribution. The most practical way to arrive at a sample size in this case is to refer to one of the existing tables for the hypergeometric confidence intervals. From these tables the sample size for a given interval and confidence level can be read directly. Tables useful for this purpose can be found in Appendix 3H.

Alternatively, the sample size required in a hypergeometric distribution can be estimated by multiplying the sample size for the binomial distribution by $N/(N+n)$

Where:

$N$ = Lot size

$n$ = Sample size required in the binomial distribution.

B. The sample size required to detect a given difference between two sample values in testing a hypothesis:

a. Variable Data

$$n = 2\left[\frac{(t_1 + t_2)\ s}{d}\right]^2$$

Where:

$n$ = Sample size

$t_1$ = Standard deviate associated with the alpha error

$t_2$ = Standard deviate associated with the beta error.

s = Sample standard deviation

d = Difference that must be detected.

b. Attribute Data

As mentioned above there is no easy practical way to calculate the sample size for attribute data. The sample size for hypothesis testing using attribute data can best be determined from the tables for minimum contrasts in Appendix 3A. These tables give values in the following format:

**Minimum Contrasts Required for Significance at the 95% Level**

| N | No. of A's in sample (1)/No. of A's in Sample (2) | | | |
|---|---|---|---|---|
| 4 | 0/4 | 1/- | | |
| 5 | 0/4 | 1/5 | 2/- | |
| 10 | 0/5 | 1/7 | 2/8 | 3/9, etc. |
| 20 | 0/5 | 1/7 | 2/9 | 3/10, etc. |

In this table N is the sample size. The values in the body of the table that appear to be proportions are written in a short-hand method which mean the following:

For a sample size of 5, the value in the first column of this row (0/4) means that if no failures are obtained in the first sample of 5, at least 4 failures must occur in the second sample of 5 before the observed difference can be declared significant at the 95% level of confidence. This, in turn, means that a sample size of 5 can only detect differences of 80% or greater. Larger sample sizes can detect smaller proportional differences. The use of these tables can, of course, be reversed to find the sample size required to detect a given difference.

C. <u>Sample size required in storage programs where time is the variable:</u>

$$N = \frac{a}{1-R}$$

Where:

N = Sample size

a = Number of failures in time (h)

h = Length of storage

R = Required reliability

## IX LABORATORY TEST METHODS FOR COMPONENTS

### 1. INTRODUCTION

It is assumed in these methods that the test item can fail in but one way. That is, the binomial distribution is applicable.

Plans should be made to conduct the laboratory experiments in two stages:

A. Survey the separate effects of the several environmental conditions of interest in one integrated factorial experiment to select the environments causing the highest failure rates.

B. Determine the ultimate reliability by means of a test of increased severity (testing to failure) using the treatment (environment) found most severe in the factorial experiment.

### 2. FACTORIAL DESIGNS

#### A. Advantages

The two-to-the-$n^{th}$ factorial designs or their optimized modifications are the most efficient experimental methods known for selecting the treatments causing the highest failure rates. This approach will reduce the magnitude and complexity of the experiments required to determine reliability. More important, all component reliabilities obtained in this manner will have a common basis of determination because the reliability of each component is defined in terms of the environment which has been experimentally found to cause the highest failure rate. This results in predicting the minimum reliability

with respect to the separate environments for each component. If all these reliabilities are acceptable the reliabilities associated with all the other environments will also be acceptable. Only in this way can valid and realistic system reliabilities be derived from component reliabilities.

See Appendix 4 for some of the more useful two-to-the-$n^{th}$ factorial designs in the form of worksheets. These designs are the most efficient known. Experiments based on these designs may be conducted without changing the treatment procedure except to arrange for the test specimens to receive the number and kind of treatments required by the particular design used. However, the best differentiation among treatments is obtained when the level of severity used will cause 50 percent of the test specimens to fail. This may cause some adjustment of the levels of the treatments used.

For the purpose of this application, the two levels of each treatment can be the presence and absence of the treatment. Alternatively, any two levels of the treatment can be used.

The number of test specimens required in the optimized designs is one more than the total number of treatments used (ref. 5). The more versatile fractional factorial designs (ref. 6) require at least 16 items for experiments containing from five through eight treatments, and at least 32 items for nine through 13 treatments. With twice these numbers of items, the latter type designs can also measure interactions, i.e., how the effect of any one environment depends upon the others. Interactions among treatments cannot be measured except by factorially designed experiments.

Factorial designs permit a type of statistical analysis that distinguishes between variations due to chance and variations having assignable causes, thereby producing more information from a given number of items than any other known procedure. These designs actually increase the effective sample size by making it possible to use each observation (or measurement) for more than one purpose.

In fact, each treatment effect is determined as though the entire experiment is conducted to determine that particular treatment effect alone. As a result, each treatment effect is determined with a precision equal to the total number of items used in the experiment. The three-treatment-design example described below demonstrates this point.

Further advantages in using factorial designs in environmental testing experiments follow:

a. No control groups are required.

b. Each treatment effect can be determined independently of all others. Thus, unambiguous conclusions can be drawn about each treatment effect.

c. Complex experiments involving a large number of treatments can be easily handled with factorial procedures.

d. This is the only experimental design in which the relationship among the treatments can be measured. The factorial design can determine whether the effect of one environmental treatment depends upon any of the others. These effects are called interactions.

e. The probability of being right or wrong can be controlled.

f. When the number of treatments used becomes large (three or more), only a fraction (1/2, 1/4, 1/8, etc.) of the total number of combinations in a factorial design need be used.

When multiple replications cannot be used and only attribute (go, no-go) data are available, these designs can still be used to take advantage of their efficiency. However, in cases of this kind the usual analysis of variance cannot be made. Instead, the usual summations are made to obtain and compare two binomial proportions (by the Fisher exact method) to determine the effect of each treatment. See example No. 1 below.

Results of factorial experiments are used as a guide to select which environment to use for determining reliability prior to conducting the test of increased severity. The factorial experiment surveys all of the environmental treatments of interest (with a minimum number of test specimens) to determine the difference, if any, among the environmental effects. A decision is then made whether to redesign the item. If the item is considered acceptable at this time, reliability is determined using the environmental treatment or treatments found to be most severe. If no differences are found among the effects, reliability can be determined by using a combination of several of the treatments considered most important from an engineering point of view. If reliability is determined by using the most severe treatments, the reliability values obtained will be lower than those obtained with the other treatments. This is a necessary condition if the system's reliability derived from the component's reliabilities is to be useful.

B. Full factorial designs (ref. 18).

These designs require more specimens per treatment than do the fractional factorial designs, but they are the only class of designs that can measure all of the interaction effects. A full factorial can be formed by writing down all of the combinations of "n" treatments, each at two levels in a multi-entry table. For example, a full two-cubed factorial can be written as follows:

$2^3$ FACTORIAL DESIGN

| | $A_1$ | | $A_2$ | |
|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_1$ | $B_2$ |
| $C_1$ | (1) | b | a | ab |
| $C_2$ | c | bc | ac | abc |

The lower case letters and the symbol (1) in the body of the table identify each of the eight ($2^3 = 8$) treatment combinations that constitute this design. These combinations are derived from their position in the table. For example, the symbol (1) is located by $A_1$ $B_1$ $C_1$ which means that all three treatments are at their lower level. The lower case letters (ac) are located by $A_2$ $B_1$ $C_2$ which means that treatments A and C are at their higher levels and that treatment B is at its lower level. In this code the lower case of the treatment letter appears in the combination only when the treatment is at its higher level. This results in the formation of all possible combinations of "n" things (treatments) taken 0, 1, 2, ... and n at a time. At least one test specimen or observation is required for each of the treatment combinations. Two or more observations at each treatment combination are required for an independent estimate of experimental error.

An equal number of observations at each treatment combination is required to keep the design orthogonal.

C. Fractional factorials (ref. 6)

As the number of treatment variables increases, the number of treatment combinations, and therefore the number of test specimens required for a complete replication, increases very rapidly. At the same time the number of higher order interactions that can be measured also increases very rapidly. This results in two undesirable situations:

a. The number of test specimens required is too large.

b. The information in the higher order interactions (three-factor interactions and above) is of little practical use. Fractional factorial designs were developed to avoid these situations and thereby improve the efficiency of designs for multi-factor experiments.

When less than all of the possible combinations in a factorial design are used, the design is said to be a fractional factorial. For the two-to-the-$n^{th}$ series there can be half, quarter, eighth, sixteenth, etc. portions of the full factorial used. These portions are called fractional replicates, where a full factorial is one replicate.

Fractional factorials cannot be used without losing or giving up some information that is available in the full factorial. However, it is planned in designing a fractional factorial to lose only the least important part of the information. Experience has shown that the higher order interactions in a full

factorial are the least important. This fact is made use of by equating new treatments to the higher order interactions. To equate one such interaction to a new variable in a full $2^6$ factorial, for example, creates a half replicate of a $2^7$ factorial. Detailed procedure for designing fractional factorials can be found in reference 18. At least one observation for each treatment combination is required to keep these designs orthogonal.

D. Treatment procedure

The factorial designs described in Appendix 4 are those most frequently used in environmental experiments. They are described in the form of treatment procedure worksheets to facilitate their use. These worksheets show, in an easy-to-follow manner, how to treat each test specimen in the various fractional factorial designs represented. They can also be used to record and analyze the test results. A blank space in the item column means that the item does not receive the corresponding treatment. A plus mark in the item column means that the item receives the corresponding treatment. The combinations of blank spaces and plus marks in the worksheets correspond to the treatment combinations in the respective fractional factorial designs. The choice of these designs should be based on the following considerations:

a. The number of treatment effects that must be determined.

b. Whether interactions can be expected to be present.

c. The precision required.

d. The number of test specimens available or that can be made available.

These considerations should be made in the order named.

The blocks in which some of the designs are divided are for the primary purpose of breaking the experiment into homogeneous parts with respect to testing equipment used, operators conducting the experiment, or climatic conditions, such as season of the year, etc. If all such things can be considered constant, then these blocks can be identified with other conditions whose effect it is desired to evaluate, such as, firing conditions, functioning conditions, temperature conditions, or different lots of material. Identifying the blocks with different conditions or material does not affect the determination of the treatment effects. The important consideration is that conditions be held constant and materials be homogeneous within the block.

E. Analysis

An example of one type of analysis that can be used with factorial designs is given in Appendix 1. This is the simplest possible analysis. The type of analysis that can be made depends upon the class of design used, the kind (attribute or variable) and amount (number of replications) of data, and the way (at random or in blocks) data were collected. Some types of analysis, such as the analysis of variance, are quite complicated. As a result, the subject of the analysis of variance (ref. 18) is not included here. It is recommended that statistical analysis of this kind be conducted by statisticians.

## 3. TESTS OF INCREASED SEVERITY

A. Introduction

These methods need be used only when one of the following situations pertains:

a. The occurrence of a failure cannot be detected by visual inspection at the time of occurrence, as it is in a tensile test.

b. The magnitude of the stress at the time of failure is not observable, as it is in the tensile test.

The intended use of these methods is to determine the magnitude of the stress at the point of failure (where the stress equals the strength), when this value is not directly observable, as in the case of the effect of vibration on timing accuracy.

The level of severity can be increased in a variety of ways, such as the following:

a. Using more extreme levels of treatment (e.g., higher or lower temperatures, higher or lower G-values, or higher or lower voltages).

b. Applying two or more treatments simultaneously.

c. Increasing the length of time the treatment is applied, as in storage tests.

When variable (quantitative) data (such as resistance in ohms, elongation in percent or closing time in seconds) are obtained, it is necessary to compare each observed value with the required value in order to determine success or failure.

B. Bruceton up-and-down method (ref. 3)

Starting with the most severe condition expected in use, test one new, unused item. If the item does not fail, increase the level of severity

(the stress) one increment* and again test one new, unused item. Continue this process of increasing the stress one increment at a time and testing one new, unused item at each increment of stress until the first failure is obtained. Then reverse the process by decreasing the stress one increment at a time and testing one new, unused item at each increment of stress until a success is obtained. Repeat the process of increasing the stress to failure and decreasing the stress to success until at least 25 test specimens are used after the first failure. Calculate the level of severity at which 50% of the specimens fail, and the associated standard deviation by the method described in Chapter 19 of ref. 3, using the number of failures for these calculations.

With this information the "reliability-in-use" can be predicted. See the examples in Appendix 1 for details of the calculations.

When the form of the distribution curve is not known or is in doubt, Chebyshev's inequality can be used. This technique is valid for <u>any</u> distribution without an assumption concerning its form. The inequality states that the amount of area under <u>any</u> distribution curve which is farther away from the mean than k standard deviation units is less than $1/k^2$. The reliability calculated by this procedure will always be less than the true value.

When the form of the failure distribution curve is practically normal, as shown by its cumulative frequency approximating a straight line on linear

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*This value can be estimated by dividing the difference between the maximum, and minimum in-use conditions by six. This is based on the assumption that the extreme in-use conditions are the 3-sigma limits.

probability paper, probability values can be found by entering a table of areas under a standard normal curve with calculated normal deviates, which equals the difference between any two levels of severity divided by the standard deviations.

C. Churchman two-stimuli method (ref. 10)

Test one new, unused item at the most severe condition in use. If the item does not fail, increase the level of severity (the stress) one increment* and, again, test one new, unused item. Continue this process of increasing the stress one increment at a time and testing one new, unused item at each increment of stress until the first failure is obtained. This procedure should cause the first failure within 5 to 10 trials, depending on the magnitude of the safety margin. Using the level of severity causing the first failure, test 10 to 20 items to determine the proportion of failures at this point. Record this proportion and the level of severity used. Then change the stress by an amount equal to about two or three increments. If the first proportion of failures exceeds 50 percent, decrease the stress, and if the first proportion is less than 50 percent, increase the stress to find a second point on the curve. Determine the proportion of failures at this point as before and record this proportion and the level of severity used.

The object is to find two levels of severity such that the proportion of failures differ by at least 20 percent, and yet have the proportions more than zero percent and less than 100 percent. From this information calculate the aver-

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*One sixth of the difference between the expected maximum and minimum use conditions.

age and standard deviation of the failure rate by the method described in Reference No. 10. Alternatively, the average and standard deviations can be obtained graphically by plotting the proportion of failures against the corresponding stress level on linear probability paper. Draw a straight line through the two points. The average stress is that stress corresponding to 50 percent failures. The standard deviation is equal to the difference between the stress at the 16 percent point, and the stress at the 50 percent point. By using these values, the reliability-in-use can be calculated as described in Appendix 1.

D. Discussion of methods.

Which of these methods will be suitable for use in any particular situation depends upon the intended purpose of the experiment. The choice can be based upon the distinguishing characteristics. Both methods are equally efficient, as they both require the same sample size for a given precision.

The two-stimuli method should be used when either of the following physical conditions exists:

a. The test results are not immediately available after each trial. This would cause undue delay in conducting the Bruceton method which requires that all trial results be known before the condition for the next trial can be determined.

b. The physical changing of the test conditions is difficult. This would cause undue work in conducting the Bruceton method which requires changing the test condition after each trial.

E. Method characteristics

a. Bruceton method

(1) Advantage:

This method leads directly to the 50 percent point with the greatest efficiency.

(2) Disadvantages:

(a) The standard deviation should be known in advance.

(b) Tests must be conducted in sequence, as the results of each test must be known before the next is conducted.

(c) Test conditions must be changed after each trial.

b. Two-stimuli method.

(1) Advantages:

(a) A number of trials can be conducted concurrently.

(b) Only two points on the curve are required.

(c) This method can be extended so that more than two points are determined. If this is done the form of the distribution can be determined.

(2) Disadvantages;

(a) The form of the strength distribution curve cannot be determined with only two points.

(b) The assumption of normality is required when only two points are used.

# X APPENDICES

## APPENDIX I

## EXAMPLES

### A. Confidence Intervals

a. Life tests. A sample of 20 components (n) which are required to operate for 240 hours (t), were subjected to a specified use condition for a period of 120 hrs. when the first component failed. The failure rate was assumed to be relatively constant and so the test was discontinued at this point in time (120 hrs.).

The sample point estimate for reliability can be calculated as follows:

$$\hat{R} = e^{-t/m}$$

When: $e = 2.7183$

$$m = \frac{1 \times 120 + (20-1)120}{1} = \frac{2400}{1}$$

$t = 240$ hours.

$$\hat{R} = (2.7183)^{-240/2400} = .90$$

This is the point estimate of the probability of no failures in 240 hours. The 90 percent two sided confidence interval for R can be calculated as follows:

$$e^{-Ut/2am} \leq R \leq e^{-Lt/2am}$$

When:

$e = 2.7183$

$U = 5.99$ (from Appendix 3C for half alpha and 2a degrees of freedom)

$L = 0.103$ (from Appendix 3C for one minus half alpha and 2a degrees of freedom)

$a = 1$ (the number of failures)

$m = 2400$

$t = 240$

alpha $= (1-0.9) = 0.1$

$$(2.7183)^{-(5.99)(240)/2x1\ (2400)} \leq R \leq (2.7183)^{-(0.103)(240)/2x1\ (2400)}$$

$$(2.7183)^{-0.3} \leq R \leq (2.7183)^{-0.005}$$

Confidence interval:

$$0.74 \leq R \leq 0.995$$

b. Binomial type data.- A sample of 20 items was taken from a lot of 100 components and tested under the use condition. No failures were obtained.

To accept this specific lot the lower limit of the 90 percent one sided confidence limit for the reliability should be taken from the tables in Appendix 3H which are based on the hypergeometric distribution. The value found in these tables is 9 defectives in the original lot of 100 items. From this then the lower limit for the true reliability of the lot is:

$$R \text{ (lower limit)} = 1 - 9/100 = 0.91$$

On the assumption that this value is acceptable and the lot is placed in the stockpile for further testing, the reliability of the items that this lot represents should now be determined from the tables in Appendix 3B which are based on the binomial distribution. From these tables, the lower limit of the true reliability of the items the lot represents is:

$$R \text{ (lower limit)} = 1.000 - 0.109 = 0.881$$

c. Systems: (1) A group of 10 telemetered missiles were flight tested. The number of failures found in each missile is as follows:

| Missile number | Number of failures |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 0 |
| 5 | 0 |
| 6 | 0 |
| 7 | 0 |
| 8 | 3 |
| 9 | 0 |
| 10 | 0 |
| Total | 3 |

The point estimate for reliability as the probability of no failures under the test condition can be calculated as follows:

$R = e^{-\bar{X}}$

When: $\bar{X} = 3/10$

Point estimate:

$R = (2.7183)^{-0.3} = 0.74$

The 90 percent two sided confidence interval for the true reliability (R) can be calculated as follows:

$e^{-U/n} \leqslant R \leqslant e^{-L/n}$

When:

$e = 2.7183$

$U = 7.75$ (from Appendix 3D).

$L = 0.818$ (from Appendix 3D).

$n = 10$

$$(2.7183)^{-7.75/10} \leqslant R \leqslant (2.7183)^{-0.818/10}$$

<u>Confidence Interval</u>:

$$0.46 \leqslant R \leqslant 0.92$$

The point estimate and 90 percent two sided confidence interval calculated from the above sample, using the binomial distribution is:

<u>Point estimate:</u>

$$R = 1 - 1/10 = 0.90$$

<u>Lower limit (for defectives)</u>:

$$p_l = \frac{a}{a + (n - a + 1)\,F_l}$$

When:

$a = 1$ (number of defective systems)

$n = 10$ (number of systems)

Degrees of freedom:

$V_1 = 2\ (10 - 1 + 1) = 20$

$V_2 = 2 \times 1 = 2$

$F_1 = 19.4$ (from Appendix 3E Table 2B)

$$p_1 = \frac{1}{1 + 10 \times 19.4} = 0.0051$$

Upper Limit (for defectives)

$$p_2 = \frac{(a + 1)\ F_2}{(n - a) + (a + 1)\ F_2}$$

When:

a = 1 (number of defective systems)

n = 10 (number of systems)

Degrees of freedom:

$V_1 = 2\ (1 + 1) = 4$

$V_2 = 2\ (10 - 1) = 18$

$F_2 = 2.93$ (from Appendix 3E table 2A)

$$p_2 = \frac{2 \times 2.93}{9 + 2 \times 2.93} = 0.396$$

Confidence interval:

$$1 - (0.396) = 0.604 < R < 1 - (0.0051) = 0.9949$$

(2) A system's reliability was calculated from a total of 200 test specimens and found to be $\hat{R} = 0.995$. The 95 percent one sided lower confidence limit is:

Upper limit (for defectives):

$$p_2 = \frac{(a + 1)\, F_2}{(n - a) + (a + 1)\, F_2}$$

When:

$a = 0.005 \times 200 = 1$ (average number of defectives)

$n = 200$

Degrees of freedom

$V_1 = 2\,(1 + 1) = 4$

$V_2 = 2\,(200-1) = 398 \approx \infty$

$F_2 = 2.37$ (From Appendix 3E Table 2A)

$$p_2 = \frac{2 \times 2.37}{(200-1) + 2 \times 2.37} = 0.0233$$

Lower confidence limit:

$$R = 0.995 - 0.023 = 0.972$$

B. Factorial Experiment

This example demonstrates how factorially designed environmental experiments can be used in combination with tests of increased severity. A simple three-treatment-experiment example is given below. The treatments used in this example are identified and defined as follows:

| Identification | Treatment |
|---|---|
| A | Transportation vibration |
| B | Flight shock |
| C | High temperature |

For purposes of the factorial design, each treatment is considered to have two levels:

a. Lower level is the absence of the treatment (designated by subscript 1).

b. Higher level is the presence of the treatment (designated by subscript 2).

The total number of possible combinations of three treatments, each at two levels, is two cubed or 8. These 8 combinations can be written in the following pattern:

| | $A_1$ | | $A_2$ | |
|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_1$ | $B_2$ |
| $C_1$ | (1) | b | a | (a + b) |
| $C_2$ | c | (b + c) | (a + c) | (a + b + c) |

A minimum of 8 items would be required for this plan, each receiving different treatment combinations as follows:

| Item number | Treatment combinations |
|---|---|
| 1 | None (1) |
| 2 | B only |
| 3 | A only |
| 4 | A + B |
| 5 | C only |
| 6 | B + C |
| 7 | A + C |
| 8 | A + B + C |

By using the letters (a, b, and c) and symbol (1) to represent the results obtained from testing the eight items, it can be shown symbolically that the treatment effects can be independently determined, using the total number of items in the entire experiment for each treatment as follows:

<u>Effect of treatment A</u>

$$a + (a + b) + (a + c) + (a + b + c) - \left[(1) + b + c + (b + c)\right] = 4A$$

<u>Effect of treatment B</u>

$$b + (b + c) + (a + b) + (a + b + c) - \left[(1) + c + a + (a + c)\right] = 4B$$

<u>Effect of treatment C</u>

$$c + (b + c) + (a + c) + (a + b + c) - \left[(1) + b + a + (a + b)\right] = 4C$$

One -fourth of these differences equals the average effect of the respective treatments. From the above equations it can be seen that the results obtained from the eight items have been used three times - once for each treatment. This procedure produces an effective sample size equal to 3 x 8, or 24 items. Each treatment effect has been determined independently of the others with a precision equal to the total number of items used in the experiment.

The above three-factor factorial can be used as an example of a fractional factorial design as follows:

| | $A_1$ | | $A_2$ | |
|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_1$ | $B_2$ |
| $C_1$ | - | b | a | - |
| $C_2$ | c | - | - | (a + b + c) |

A minimum of four items is required in this design. As before, the separate effects can be determined by a process of summation and subtraction as follows:

Effect of treatment A

$$a + (a + b + c) - (b + c) = 2A$$

Effect of treatment B

$$b + (a + b + c) - (a + c) = 2B$$

Effect of treatment C

$$c + (a + b + c) - (a + b) = 2C$$

One-half of these differences equals the average effect of the respective treatments.

When there is only one item available for each treatment combination, and only success and failure data are available, the usual analysis of variance cannot be used but the remaining advantages of the factorial design (given previously) still pertain. The above differences, which will be binomial proportions in this case, can be compared by the Fisher exact method for 2 x 2 contingency tables (ref. 7) to determine the treatment effects. A very convenient set of tables for this purpose can be found in ref. 8,* which contains tables of minimum contrasts based on Fisher's exact method.

a. Sample calculations. The full three-factor experiment used above might give the following typical set of results, when the figure "one" is entered as a "failure" and a "zero" is entered as a "success." It is

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*"See also Appendix 3A"

assumed that a knowledge of the item being tested has led to the decision that transportation vibration, flight shock, and high temperature <u>in that order</u>, are the three environmental conditions most likely to affect the important functioning characteristic of this item; this characteristic is waterproofness. The treatment procedure and worksheet (to record results) for this experiment would be the following two-entry table. A plus mark in the item column means that the item received the corresponding treatment, while a "blank" means that the item did not receive the treatment.

<u>Treatment procedure</u>

| Order of Treatment | Item Number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-4 | 5-8 | 9-12 | 13-16 | 17-20 | 21-24 | 25-28 | 29-32 |
| Transportation vibration (A) | | | + | + | | | + | + |
| Flight shock (B) | | + | | + | | + | | + |
| High temperature (C) | | | | | + | + | + | + |
| Results: Replication 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 3 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| 4 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| Totals | 2 | 2 | 0 | 3 | 0 | 2 | 4 | 4 |

The results of one complete replication should be obtained under a single set of controlled conditions (e.g., in the same day, same operators, same instruments, etc.), before going to the next replication. This will make it possible to determine whether conditions changed significantly during the experiment.

Placing these results in the usual factorial matrix, the following table would be obtained:

| | $A_1$ | | $A_2$ | |
|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_1$ | $B_2$ |
| $C_1$ | 1 | 0 | 0 | 1 |
| | 0 | 0 | 0 | 0 |
| | 0 | 1 | 0 | 1 |
| | 1 | 1 | 0 | 1 |
| | 2 | 2 | 0 | 3 |
| $C_2$ | 0 | 0 | 1 | 1 |
| | 0 | 1 | 1 | 1 |
| | 0 | 1 | 1 | 1 |
| | 0 | 0 | 1 | 1 |
| | 0 | 2 | 4 | 4 |

In preparation for analyzing these results, the usual summing process would give the following series of two-factor tables:

<u>Summing over A</u>:

| | $B_1$ | $B_2$ | Row Totals |
|---|---|---|---|
| $C_1$ | 2 | 5 | 7 |
| $C_2$ | 4 | 6 | 10 |
| Column totals | 6 | 11 | 17 |

Summing over B:

| | $A_1$ | $A_2$ | Row Totals |
|---|---|---|---|
| $C_1$ | 4 | 3 | 7 |
| $C_2$ | 2 | 8 | 10 |
| Column totals | 6 | 11 | 17 |

Summing over C:

| | $A_1$ | $A_2$ | Row Totals |
|---|---|---|---|
| $B_1$ | 2 | 4 | 6 |
| $B_2$ | 4 | 7 | 11 |
| Column totals | 6 | 11 | 17 |

Note that approximately 50 percent (17/32) failures were obtained. This is the condition under which the greatest resolution of effects is obtained. Each one of th^ marginal totals is the sum of 16 observations. The results can now be analyzed and interpreted as follows:

| Source | | Effects | Test of Significance* |
|---|---|---|---|
| Main Effects | | | |
| Transportation vibration (A) | | 6/16 vs 11/16 | Non-significant |
| Flight shock (B) | | 6/16 vs 11/16 | Non-significant |
| High temperature (C) | | 7/16 vs 10/16 | Non-significant |
| Replication | | | |
| | 1. | 4/8 | Non-significant |
| | 2. | 3/8 | |
| | 3. | 5/8 | |
| | 4. | 5/8 | |

| Source | Effects | Test of Significance* |
|---|---|---|
| Interactions | | |
| A x B | 8/16 vs 9/16 | Non-significant |
| A x C | 5/16 vs 12/16 | Significant |
| B x C | 8/16 vs 9/16 | Non-significant |
| A x B x C | 6/16 vs 11/16 | Non-significant |

* From Appendix 3A Table 1.

b. Interpretation (when the above order is used)

(1) The replication effect is not significant. This means that the conditions of the experiment did not change significantly from the beginning to the end. Therefore, the results can be accepted as valid from this standpoint.

(2) None of the effects is significant except the A x C interaction. This means that the combination of transportation vibration and high temperature treatments has caused a larger difference in the number of failures than would be expected due to chance variations alone.

(3) None of the treatments taken alone is significant, although the flight shock and transportation vibration effects approach significance. These results suggest the need for additional flight-shock and transportation vibration tests if these treatments are considered important from an engineering point of view.

These results show clearly that the combination of transportation vibration and high temperature is the most severe condition. From this, reliability should be defined in terms of waterproofness after trans-

portation vibration and high temperature. If this reliability is acceptable, the waterproofness reliabilities under all of the other conditions used will also be acceptable.

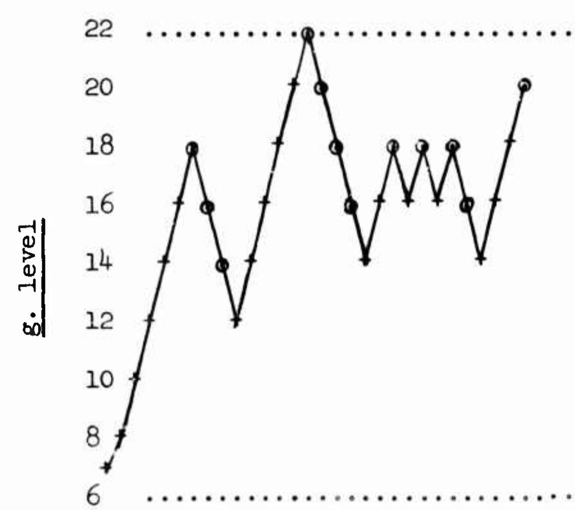
C. Tests of Increased Severity

a. Bruceton method (ref. 3). The results from the factorial experiment described above show that the Bruceton "up-and-down" procedure can be conducted by varying the severity (g-force level) of the transportation vibration treatment and using the same high temperature (without variation) as that used in the factorial experiment. This can be done since the high temperature main effect (difference in the number of failures between the presence and absence of this treatment) is not significant. Assuming that the average g-force expected in use is 4 g's with a standard deviation of 2 g's, then using increments of 2 g's and starting at 6 g's, apply the vibration and temperature treatments and conduct the waterproofness test on one new, unused item. If the item does not fail, increase the g-level one increment and again test one new, unused item. Continue this process of increasing the g-level one increment at a time and testing one new, unused item at each g-level until the first failure is obtained. Then reverse the process by decreasing the g-level one increment at a time and testing one new, unused item at each g-level until an item successfully passes the waterproofness test. Repeat the process of increasing the g-level to failure and decreasing the g-level to success, until at least 12 items have been made to fail in this manner.

Ordinarily the Bruceton method would not be used for this test. Since the result of each test must be known before the next test can be run, this method would consume far too much time. It is used here for demonstration purposes only. In practice the Two-stimuli method should be used for a test of this kind, since several of the tests could be conducted concurrently with a considerable saving of time.

Record the results in graphic form for convenience and count the number of failures obtained at each g-level. The following can be used as an example of the type of observed data that could be obtained:

Diagram Number I




| | Distribution of failures |
|---|---|
| | 1 |
| | 2 |
| | 5 |
| | 3 |
| | 1 |
| Total | 12 |

where:
+ = Success.
⊙ = Failure.

Calculate the average ($\overline{X}$) and standard deviation (s) of the failure rate as follows (ref. 3) :

Where:

$$A = \sum_{x=0}^{x=k} fx; \qquad B = \sum_{x=0}^{x=k} f(x)^2$$

k = Number of g-levels over which the failures are distributed.

f = Observed frequency of failure.

x = Code numbers used for ease of calculation.

$\bar{X} = y' + d\ (A/N - 1/2)$

$$S = 1.62\ d \left( \frac{NB - A^2}{N^2} + .029 \right)$$

Where:

y' = Lowest level at which a failure is obtained.

d = 2 g's. - the increment used.

N = Total number of failures.

This formula for the standard deviation is an approximation which is quite accurate when $\frac{(NB - A^2)}{N}$ exceeds 0.3.

Using these formulas and the observed data, the average and standard deviation for the above example can be calculated as follows:

| f | x | fx | $fx^2$ |
|---|---|---|---|
| 1 | 4 | 4 | 16 |
| 2 | 3 | 6 | 18 |
| 5 | 2 | 10 | 20 |
| 3 | 1 | 3 | 3 |
| 1 | 0 | 0 | 0 |
| N = 12 | | A = 23 | B = 57 |

$$\bar{X}_2 = 14 + 2(23/12 - 1/2) = 16.8 \text{ g's}$$

$$s_2 = 1.62 \times 2\left[\frac{12 \times 57 - (23)}{(12)^2} + 0.029\right] = 3.58 \text{ g's}$$

The cumulative frequency of the observed failure distribution plotted on linear probability paper closely approximates a straight line. From this it can be concluded that the assumption of normality is sufficiently valid for use as a basis to predict the expected reliability-in-use.

Therefore, the point estimate for the (waterproofness) reliability-in-use can be calculated as follows:

$$\hat{R} = 1 - P$$

Where:

$P$ = The probability of failure-in-use.

The probability of failure-in-use can be measured by the area under the normal curve associated with the Z-value calculated as follows:

$$Z = \frac{(X_1 - X_2) - (M_1 - M_2)}{\sqrt{\sigma_1^2 + \sigma_2^2}}$$

When: $X_1 \geq X_2$ a failure is obtained.

$$Z \geq \frac{M_2 - M_1}{\sqrt{\sigma_1^2 + \sigma_2^2}}$$

Where:

$X_1$ = Any stress value.

$X_2$ = Any strength value.

$M_1$ = True mean of the stress distribution.

$M_2$ = True mean of the strength distribution.

$\sigma_1^2$ = True variance of the stress distribution.

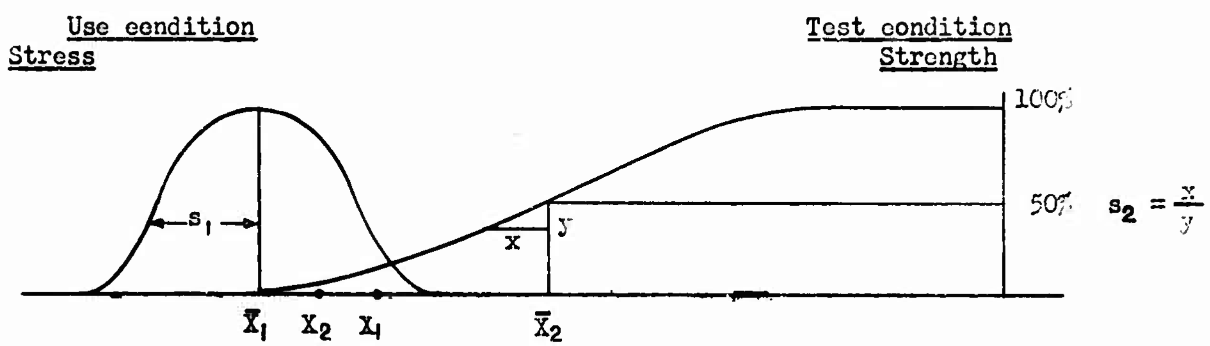
$\sigma_2^2$ = True variance of the strength distribution.

$\frac{M_2 - M_1}{M_1}$ = Safety margin.

The relation between the safety margin and a measure of probability is shown above. If the product of the safety margin and the average stress in use is divided by $\sqrt{\sigma_1^2 + \sigma_2^2}$, we have a measure of probability - the standard deviate.

Graphically, the relationship between the test conditions and use condition can be depicted as follows:

Diagram Number II




Where:

The horizontal axis represents the g-forces increasing to the right. The bell shaped curve represents the distribution of g-forces under the use condition (the stress curve).

The S-shaped curve represents the distribution of failures under the test condition obtained by the Bruceton method (the strength curve).

When:

$\overline{X}_1$ = 4 g's - an estimate of $M_1$ the true average stress.

$s_1$ = 2 g's - an estimate of $\sigma_1$ the true standard deviation of the stress.

$\overline{X}_2$ = 16.8 g's - an estimate of $M_1$ the true average strength (the 50 percent point on the strength curve.)

$s_2$ = 3.48 g's - an estimate of $\sigma_2$ , the true standard deviation of the strength.

$X_1$ = any stress value.

$X_2$ = any strength value.

From the above, the <u>average</u> (point estimate) reliability-in-use can be calculated as follows:

$$T \geq \frac{\overline{X}_2 - \overline{X}_1}{\sqrt{s_1^2 + s_2^2}}$$

$$T \geq \frac{16.8 - 4.0}{\sqrt{(3.58)^2 + (2)^2}} \geq 3.12$$

From Appendix 3G the probability of a failure-in-use associated with this T-valu is: $\hat{P}_1 \leq 0.00090$.

<u>Reliability Point Estimate</u>:

$$\hat{R} \geq 1\text{-}0.00090 \geq 0.99910$$

The lower confidence limit for the one sided 95 percent confidence level can be calculated as follows:

The 95 percent single sided lower confidence limit of the average strength:

$$\overline{X}_2 - \frac{ts_2}{\sqrt{n_2}} \text{ (see ref. 3)}$$

Where:

$\bar{X}_2$ = 16.8 - the observed average strength.

t = 1.80 - the t-value associated with the single sided 95 percent confidence level and eleven ($n_2$-1) degrees of freedom found in Appendix 3F.

$s_2$ = 3.58 - the standard deviation of the strength.

$n_2$ = 12 - the sample size used to determine the strength.

Then the 95 percent single sided lower confidence limit for the strength is:

$$16.8 - \frac{(1.80)\ (3.58)}{\sqrt{12}} = 14.94$$

The lower bound of the reliability in-use can be calculated as follows:

$$T_2 \geq \frac{14.94 - 4.0}{\sqrt{(3.58)^2 + (2)^2}}$$

$T_2 \geq 2.67$

The probability of a failure-in-use associated with this T-value (appendix 3G) is:

$\hat{P} \leq 0.0038$

The lower bound of the reliability-in-use is:

$$R \geq 1 - 0.0038 \geq 0.9962$$

These values are the predicted reliabilities-in-use. They have been demonstrated with a total of 62 items (32 in the factorial experiment and 30 in the Bruceton up-and-down method). To demonstrate this reliability by doing all of the testing at the use condition, would require that 786 items be tested without a single failure.

b. Two-stimuli method. The results of the factorial experiment described above can also be used to exemplify this method of predicting reliability-in-use. Beginning at one increment (one standard deviation) above the average use-condition, the g-level can be increased one increment at a time (as in the Bruceton method) until the first failure is obtained. The proportions of failures at this point and at a point three increments above this point are as follows:

| g-level | Proportions of failures |
|---|---|
| 12.0 | 1/10 |
| 18.0 | 6/10 |

This method (under these conditions) required a total of 23 test specimens - 3 before obtaining the first failure and 10 at each of the two points on the curve.

Calculate the average ($\overline{H}$) and the standard deviation (S) of the failure rate as follows (ref. 10): $\overline{H} = X_1 + d\,(\overline{H})'$

$$S = d\,S'$$

Where:

$X_1$ = 12 g's the weaker stimulus.

$p_1$ = 0.10, the proportion of failures at 12 g's.

$p_2$ = 0.60, the proportion of failures at 18 g's.

d = 6 g's (18 - 12 g's) the increment used.

$\bar{H}'$ = 0.8350, the factor associated with $p_1$ and $p_2$ in table II of ref. 10 for calculating the average.

$S'$ = 0.6515, the factor associated with $p_1$ and $p_2$ in table II of ref. 10 for calculating the standard deviation.

$\bar{H}$ = Average (50 percent point) of the failure distribution (strength) curve.

S = Standard deviation of the failure distribution (strength) curve.

When:

$\bar{H}$ = 12.0 + 6.0 (0.8350) = 17.0 g's.

S = (0.6515) = 3.9 g's.

These same values can be obtained graphically by simply plotting the proportion of failures versus the corresponding g-forces on linear probability paper. The average is the g-force corresponding to the 50 percent point, and the standard deviation is the slope of the line thru the two points, or is the difference between the g-forces corresponding to the 16 and 50 percent points.

Using these values for the average and standard deviation, the point estimate and lower confidence limit for the (waterproofness) reliability-in-use can be calculated as in the examples for the Bruceton method.

## APPENDIX 2

## GLOSSARY OF TERMS

**Attribute**

A qualitative characteristic (such as acceptable or rejectionable, success or failure, rusted or not rusted, wet or dry, black or white, miss or hit), which can have two or more categories.

**Attribute data**

Data denoting a qualitative characteristic. This type of data can have only discrete values and is derived by counting the number of times each category occurs, such as, four failures and six successes.

**Best Estimate**

An estimator is said to give the "best estimate" of the true population parameter if it complies with the following requirements which are taken as the definition of the word "best":

A. The average of all possible values of the estimator equals the true population parameter.

B. In any particular case the deviation of the estimator from the true population parameter is less than any other possible estimator.

**Binomial data**

Attribute data that has only two categories or only two possible outcomes such as success and failure.

**Blocking**

In experimental design, a block is a homogeneous group of items, all treated under controlled conditions such as by the same operator,

the same calibration of the measuring instrument, or the same short period of time. The purpose of blocking is to reduce the effect of the heterogeneity of material and changing conditions by dividing the experiment into rational subdivisions.

Confidence interval

The range of values within which the true population parameter (mean or standard deviation) is expected to lie. The confidence level associated with this interval is a probability statement expressing the proportion of the time the true value is expected to be within the interval.

Confidence level

The confidence level is the probability of being right in our predictions or conclusions. This value is equal to one minus the error of the first kind. The magnitude of this error that can be tolerated should be established during the planning stage of the experiment (prior to data collecting) based on the consequences of being wrong and thereby establish the confidence level.

Confounding

When certain comparisons can be made only for treatments in combination and not for separate treatments, those treatment effects are said to be confounded. Conclusions drawn about the separate effects in this case will be ambiguous. Confounding is often a deliberate feature of the experimental design but may arise from inadvertent imperfections.

Criterion

The measurable characteristic used to evaluate the treatment effects. Criteria can also be considered as the dependent variables

used as a standard of reference to distinguish between the independent variablo effects. Velocity, functioning time, voltage, rate of detonation, etc., can be criteria.

Degrees of freedom

The number of degrees of freedom is equal to the number of independent observations minus the number of parameters (such as tho mean) estimated. That is, degrees of freedom usually equal the sample size minus one. In computing the variance for example, only (n-1) of the deviations from the mean can be independent. The $n^{\underline{th}}$ deviation has to be restricted in order to make the sum of all "n" deviation total zero.

Effect

In statistics the meaning of the word effect is synonomous with the word difference. A treatment effect is the difference caused by the treatment, such as the difference in the measured results before and after the treatment.

Efficiency

An estimator or an experimental design is said to be efficient if a given precision can be obtained with a smaller sample size or with less time and cost.

Error

Chance variations are considered errors in statistics. Deviations from the expected value, due to chance, form the familiar bell shaped normal curve. This is sometimes called the normal curve of error. Error in the statistical sense does not imply that a mistake has been made.

Error mean square

The error mean square is the variance and is also the square of the standard deviation. It is calculated by finding the sum of the squares of the deviations of the individual sample values from their mean and dividing by the number of degrees of freedom.

Error of estimate

The difference between an estimated value and the true value.

Error of first kind

If, as a result of a statistical test, the null hypothesis is rejected when it is true, then it is said that an error of the first kind is committed. This type of error is also called:

a. The alpha error.

b. The producer's risk.

c. The risk of rejecting good material.

The magnitude of this error should be established from the consequences of being wrong and controlled at that level by calculating the required sample size.

Error of observation

An error of observation arises from imperfections in the method of measurement or from human mistakes.

Error of second kind

If, as a result of a statistical test, the null hypothesis is accepted when it is false, then it is said that an error of the second kind is committed. This type of error is also called:

a. The beta error.

b. The consumer's risk.

c. The risk of accepting poor material.

After the error of the first kind has been established, the error of the second kind is controlled by the sample size. This error is very important in Ordnance work because it controls the probability of accepting poor material.

Estimate

An estimate is the particular value obtained by an estimator in a given set of circumstances.

Estimator

An estimator is the method of estimating a constant of a parent population. It is usually expressed as a function of sample values (such as the average) and therefore is a variable.

Experimental error

Experimental error is the chance variation to be expected under controlled conditions. It is not the result of mistakes in experimental design or avoidable imperfections in technique.

Experimental unit

An experimental unit is the smallest subdivision of the experimental material that can receive different treatments in the actual experiment. It is also known as a test specimen.

Factor

A factor is a quantity under examination (in an experiment) as a possible cause of variation. In practice the terms factor, treatment, and variable are loosely used interchangeably in this sense.

Factorial experiment

An experiment which investigates all of the possible treatment combinations that may be formed from the factor versions under investigation.

Fractional factorial experiment

This is a fractional part of a factorial experiment. When three or more factors are used in a factorial experiment only a fractional part (1/2, 1/4, 1/8) of the total number of possible combinations need be used if certain of the interactions can be considered negligible. This device can be resorted to without loss of efficiency when the number of factors to be investigated makes the full factorial so large that it is impractical to use.

Hypothesis

A hypothesis is a contention based on preliminary observation of what appears to be fact. It is the prediction derived from past experience that is to be verified or rejected by experimentation. Natural "laws" are hypothesis which have been subjected to various tests and have been accepted. In statistical tests two hypothesis are used:

a. The null hypothesis is a hypothesis of "no difference." This is the assumption that the contemplated changes will make no difference. This hypothesis is formulated for the express purpose of being rejected in the process of controlling the error of the first kind.

b. The alternative hypothesis is the operational statement of the experimenter's prediction. It is the positive statement that the changes will make a detectable difference. If the resultant data reject the null hypothesis the alternative hypothesis will be accepted.

Independence

Measurements are independent if the taking of one does not effect any of the others. That is, there is no correlation among them. Treatment effects are said to be independent if, in an orthogonal experiment, there is no interaction.

Interaction

Interaction is a measure of the extent to which the effect of changing the level of one factor epends on the level of another factor. Interaction is said to be present when a certain particular combination of treatments produces unusual (unpredictable) results. Only factorial type experiments can measure interaction effects.

Levels

The level of a factor (or treatment) denotes the intensity with which it is used or applied. Levels of a factor may be either qualitative, such as presence and absence of the treatment, or the levels may be quantitative, such as the number of volts applied.

Main effects

A main effect is the average difference (s) between (or among) the levels of a variable or treatment when averaged over all of the other treatments which form a part of the same orthogonal experiment. If significant interaction effects are present, care must be taken in stating the main effects. In such cases the level of the interacting treatment associated with the stated main effect must also be stated.

Normal distribution

The physical appearance of a normal distribution is the familiar bell-shaped curve. A normal distribution can not be represented by only a single curve. It is actually a family of curves whose areas under them are distributed in a very specific manner. A normal curve has the following properties:

a. Continuous.

b. Symetrical.

c. Unimodal.

d. Asymptotic to x-axis.

e. Completely described by the mean and standard deviation.

f. The distance between the ordinate of the mean and the inflection point on either half of the curve is equal to the standard deviation.

g. The area included between the ordinates drawn thru the two inflection points equals 68.27 percent of the total area under the curve.

Parameter

A parameter is a quantity such as the mean or standard deviation, calculated from a population. The population mean and standard deviation are parameters and as such are constants. In actual practice parameters are usually unknown.

Point estimate

This is one of the two principal bases of estimation in statistical analysis. Point estimation endeavors to give the best single estimated value of a parameter, as compared with interval estimation which specifies a range of values. Since a point estimate includes an error of measurement,

the difference between a point and an interval is not always clear. In interpretation they often amount to the same thing.

Population

A population is any set of individuals or objects having some common observable characteristic. The term population may refer either to the individuals measured or to the measurements themselves. A population is usually considered to consist of an infinite number of individuals. The curve of the normal distribution graphically represents a population.

Precision

Precision is a property of the measuring system and refers to the ability of the system to reproduce previous results. Precision should be distinguished from accuracy which refers to the magnitude of the difference between the observed values and the true value of the characteristic being measured. Precision should also be distinguished from the sensitivity of the measuring system which is the ability of the system to detect actual variations that occur. An insensitive system will give the false impression of high precision (small variation).

Probability

In applied statistics probability can be considered a relative frequency or a simple proportion. Probability is the relative frequency of events in a very long sequence of trials. For example, the probability of a particular coin falling heads up is the ratio of the number of heads occuring to the total number of trials in a sequence of

trials. In somewhat similar fashion a normal distribution can be formed from a very large body of data. As a result, the area under the normal curve is used as a measure of probability.

Randomization

The word randomization has a very special technical meaning in statistics. It means rearranging a group of items or numbers into a series or sequence having no recognizable pattern. The essential feature of randomization is that it should be an objective impersonal procedure. Whether or not proper randomization has been obtained should not be determined by an examination of the individuals randomized, but rather by examining the properties of the procedure by which randomization was accomplished. The objectives of randomizing are as follows:

a. To give the laws of chance free play.

b. To give every possible sequence an equally likely chance of occurring.

c. To assure that adjacent individuals are completely independent.

d. To remove biases of any kind.

e. To prevent systematic error.

Reliability

In missile technology reliability is the probability of success in performing a specified function, under a specified condition, for a specified length of time, and after a specified period of time. From this it is clear that any particular component can have many reliability values simultaneously-one for every possible combination of function, condition, and time.

Replication

Replication is the performance of an experiment in its entirety one or more times. Two or more replications are usually for the purpose of obtaining an independent measure of the sampling or experimental error. Replication should be distinguished from repetition, in that, replication means repetition carried out under the same conditions, at the same time, by the same operators, with the same instruments, and with the same homogeneous material. A replication is sometimes considered a block.

Sample

Any finite subset of a population is a sample of that population.

Sample size

The sample size is the number of items or individual values in the sample.

Standard deviation

a. Definition The standard deviation is a measure of the variation among the individual values in a sample and a measure of the dispersion among the individual values in a frequency distribution. It is the most efficient measure of precision and is designated by the lower case letter "s". This value is large for large variations (poor precision) and small for small variations (good precision). Although the word "error" is sometimes used in referring to the standard deviation or its square (the variance) these values can measure only precision in the true sense of the word. They do not measure accuracy.

If the term standard deviation is stated alone and not modified or otherwise qualified by an accompanying word or phrase, it is understood

that the term refers to the standard deviation of the individual sample measurements. This value can be calculated from the sample data and is a <u>variable</u>.

There are two additional kinds of standard deviations:

1. The <u>population standard deviation</u> which is a <u>constant</u> and cannot be calculated from the sample data. This value is designated by the small Greek letter sigma and is usually considered unknown unless a very large body of data is collected to measure it or unless it is assigned a value as in a specification requirement.

2. The <u>standard deviation of the mean</u> is a measure of the variation among several sample averages. This value can be calculated from sample data and it is a variable. It is usually designated by the lower case letter "s" with the subscript $\bar{X}$. If all of the sample sizes are equal this value can be calculated by dividing the standard deviation of the individual sample values by the square root of the number of individual values in each of the samples.

b. <u>Calculation of the standard deviation for variable type data</u>:

$$s = \sqrt{\frac{\sum_{i=1}^{i=n} (\bar{X} - x_i)^2}{n-1}} = \sqrt{\frac{\sum_{i=1}^{i=n} (x_i)^2 - \frac{\left(\sum_{i=1}^{i=n} x_i\right)^2}{n}}{n-1}}$$

where:

$s$ = Sample standard deviation of the individual values.

$\sum_{i=1}^{i=n}$ = This symbol means to add all of the "n" quantities designated by the parentheses. It is read: sum from i=1 to i=n.

$\bar{X}$ = Sample average.

$x_i$ = Any one of the "n" values that make up the sample.

$n$ = Sample size or the number of individual values that make up the sample.

$(n-1)$ = Number of degrees of freedom associated with the standard deviation.

$s^2$ = Sample variance of the individual values.

$s/\sqrt{n}$ = Sample standard deviation of the mean ($s_{\bar{X}}$).

Statistic

A statistic is a summary value calculated from a sample of values. The sample mean is a statistic and as such is a variable, not a constant.

Statistical significance

A difference or an effect is said to be statistically significant if it is greater than that expected due to chance alone.
If the probability (chance) is very small that a value came from a particular population, the difference between that value and the mean of the population is said to be statistically significant.

Statistics

The subject of statistics is the science of collecting, analyzing, and interpreting numerical data.

Treatment

In experimentation, a treatment is a stimulus which is applied in order to observe the effect on the experimental situation. A treatment may refer to a physical substance, a procedure, or anything which is capable of controlled application. In statistical parlance a treatment is the variable being studied or the experimental condition.

True value

The true value is another expression for a population parameter such as the population mean or standard deviation. The true value can also be the expected value or the theoretical value.

Validation

Validation is a procedure which provides, by reference to independent sources, evidence that an inquiry is free from bias, or otherwise conforms to its declared purpose. In statistics it is usually applied to a sample investigation with the object of showing that the sample is reasonably representative of the population and that the information collected is accurate.

Variable

A variable is any quantity or measurable characteristic which varies. More precisely in statistics a variable is any quantity which can have any one of a specified set of values.

Variable data

Variable data is a term used to describe a type of data that can vary on a continuous scale from zero to infinity. Weight in pounds, length in feet, E.M.F. in volts, and temperature in degrees are variable type data.

Variance

Variance is a measure of variation in a sample, or dispersion in a frequency distribution. The variance is equal to the square of the standard deviation.

Appendix 3A

Table I

Minimum contrasts 95% (two sided) Test

N = total number of trials in each sample.

| N | No. of A's in Sample (1)/No. of A's in Sample (2) |
|---|---|
| 4 | 0/4 1/- |
| 5 | 0/4 1/5 2/- |
| 6 | 0/5 1/6 2/- |
| 7 | 0/5 1/6 2/7 3/- |
| 8 | 0/5 1/6 2/7 3/8 4/- |
| 9 | 0/5 1/6 2/8 3/8 4/9 5/- |
| 10 | 0/5 1/7 2/8 3/9 4/10 5/10 6/- |
| 11 | 0/5 1/7 2/8 3/9 4/10 5/11 6/11 7/- |
| 12 | 0/5 1/7 2/8 3/9 4/10 5/11 6/12 7/12 8/- |
| 13 | 0/5 1/7 2/8 3/9 4/10 5/11 6/12 7/13 8/13 9/- |
| 14 | 0/5 1/7 2/8 3/10 4/11 5/12 6/12 7/13 8/14 9/14 10/- |
| 15 | 0/5 1/7 2/9 3/10 4/11 5/12 6/13 7/14 8/14 9/15 10/15 11/- |
| 16 | 0/5 1/7 2/9 3/10 4/11 5/12 6/13 7/14 8/15 9/15 10/16 11/16 12/- |
| 17 | 0/5 1/7 2/9 3/10 4/11 5/12 6/13 7/14 8/15 9/16 10/16 11/17 12/17 13/- |
| 18 | 0/5 1/7 2/9 3/10 4/11 5/12 6/13 7/14 8/15 9/16 10/17 11/17 12/18 13/18 14/- |
| 19 | 0/5 1/7 2/9 3/10 4/11 5/12 6/14 7/14 8/15 9/16 10/17 11/18 12/18 13/19 14/19 15/- |

Appendix 3A

Table 1 (Continued)

Minimum contrasts 95% (two sided) Test

N = total number of trials in each sample.

| N | No. of A's in Sample (1)/No. of A's in Sample (2) |
|---|---|
| 20 | 0/5 1/7 2/9 3/10 4/11 5/13 6/14 7/15 8/16 9/16 10/17 11/18 12/19 13/19 14/20 15/20 16/- |
| 30 | 0/6 1/8 2/9 3/11 4/12 5/13 6/15 7/16 8/17 9/18 10/19 16/25 17/25 20/28 21/28 23/30 24/30 25/- |
| 40 | 0/6 1/8 2/9 3/11 4/12 5/14 6/15 7/16 8/18 9/19 10/20 23/33 24/33 27/36 28/36 30/38 31/38 33/40 34/40 35/- |
| 50 | 0/6 1/8 2/10 3/11 4/13 5/14 6/15 7/17 8/18 9/19 10/20 11/22 29/40 30/40 34/44 35/44 38/47 39/47 41/49 42/49 44/50 45/- |
| 60 | 0/6 1/8 2/10 3/11 4/13 5/14 6/16 7/17 8/18 9/20 10/21 11/22 12/23 13/24 14/26 35/47 36/47 41/52 42/52 45/55 46/55 48/57 49/57 51/59 52/59 53/60 54/60 55/- |
| 70 | 0/6 1/8 2/10 3/11 4/13 5/14 6/16 7/17 8/18 9/20 10/21 11/22 12/23 13/25 18/30 19/32 20/33 39/52 40/52 46/58 47/58 51/62 52/62 55/65 56/65 58/67 59/67 61/69 62/69 63/70 64/70 65/- |
| 80 | 0/6 1/8 2/10 3/11 4/13 5/14 6/16 7/17 8/19 9/20 10/21 11/22 12/24 13/25 14/26 15/27 16/29 23/36 24/38 43/57 44/57 52/65 53/65 57/69 58/69 62/73 63/73 65/75 66/75 68/77 69/77 71/79 72/79 73/80 74/80 75/- |

Appendix 3A

Table 1 (Continued)

Minimum contrasts 95% (two sided) Test

N = total number of trials in each sample.

| N | No. of A's in Sample (1)/ No. of A's in Sample (2) |
|---|---|
| 90 | 0/6 1/8 2/10 3/11 4/13 5/14 6/16 7/17 8/19 9/20 10/21 11/23 12/24 13/25 14/26 15/28 20/33 21/35 31/45 32/47 44/59 45/59 56/70 57/70 63/76 64/76 68/80 69/80 72/83 73/83 75/85 76/85 78/87 79/87 81/89 82/89 83/90 84/90 85/- |
| 100 | 0/6 1/8 2/10 3/11 4/13 5/15 6/16 7/17 8/19 9/20 10/21 11/23 12/24 13/25 14/27 18/31 19/33 25/39 26/41 60/75 61/75 68/82 69/82 74/87 75/87 78/90 79/90 82/93 83/93 86/96 87/96 88/97 89/97 91/99 92/99 93/100 94/100 95/- |
| 150 | 0/6 1/8 2/10 3/12 4/13 5/15 6/16 7/18 8/19 9/20 10/22 11/23 12/24 13/26 14/27 15/28 16/30 19/33 20/35 25/40 26/42 32/48 33/50 41/58 42/60 91/109 92/109 101/118 102/118 109/125 110/125 116/131 117/131 121/135 122/135 125/138 126/138 129/141 130/141 133/144 134/144 136/146 137/146 139/148 140/148 141/149 142/149 143/150 144/150 145/- |
| 200 | 0/6 1/8 2/10 3/12 4/13 5/15 6/16 7/18 8/19 9/21 10/22 11/23 12/25 13/26 14/27 15/29 18/32 19/34 22/37 23/39 27/43 28/45 33/50 34/52 41/59 42/61 51/70 52/72 65/85 66/87 114/135 115/135 129/149 130/149 140/159 141/159 149/167 150/167 156/173 157/173 162/178 163/178 167/182 168/182 172/186 173/186 176/189 177/189 180/192 181/192 183/194 184/194 186/196 187/196 189/198 190/198 191/199 192/199 193/200 194/200 195/- |

Appendix A

Table 1 (Continued)

Minimum contrasts 95% (two sided) Test

N = total number of trials in each sample.

| N | No. of A's in Sample (1)/ No. of A's in Sample (2) |
|---|---|
| 300 | 0/6 1/8 2/10 3/12 4/13 5/15 6/16 7/18 8/19 9/21 10/22 11/24 12/25 13/26 14/28 15/29 16/30 17/31 18/33 19/34 20/35 21/37 24/40 25/42 29/46 30/48 35/53 36/55 41/60 42/62 48/68 49/70 56/77 57/79 66/88 67/90 78/101 79/103 95/119 96/121 180/205 181/205 198/222 199/222 211/234 212/234 222/244 223/244 231/252 232/252 239/259 240/259 246/265 247/265 253/271 254/271 259/276 260/276 264/280 265/280 268/283 269/283 273/287 274/287 277/290 278/290 280/292 281/292 283/294 284/294 286/296 287/296 289/298 290/298 291/299 292/299 293/300 294/300 295/- |

Appendix 3A

Table 2

Minimum contrasts 99% (two sided) Test

N = total number of trials in each sample

| N | No. of A's in Sample (1)/ No. of A's in Sample (2) |
|---|---|
| 5 | 0/5 1/- |
| 6 | 0/6 1/- |
| 7 | 0/6 1/7 2/- |
| 8 | 0/6 1/8 2/8 3/- |
| 9 | 0/6 1/8 2/9 3/9 4/- |
| 10 | 0/7 1/8 2/9 3/10 4/- |
| 11 | 0/7 1/8 2/9 3/10 4/11 5/- |
| 12 | 0/7 1/8 2/10 3/11 4/11 5/12 6/- |
| 13 | 0/7 1/9 5/13 6/13 7/- |
| 14 | 0/7 1/9 6/14 7/14 8/- |
| 15 | 0/7 1/9 7/15 8/15 9/- |
| 16 | 0/7 1/9 2/10 3/12 4/13 5/14 6/14 8/16 9/16 10/- |
| 17 | 0/7 1/9 2/11 7/16 8/16 9/17 10/17 11/- |
| 18 | 0/7 1/9 2/11 8/17 9/17 10/18 11/18 12/- |
| 19 | 0/7 1/9 2/11 9/18 10/18 11/19 12/19 13/- |
| 20 | 0/7 1/9 2/11 4/13 5/15 6/16 7/16 10/19 11/19 12/20 13/20 14/- |
| 30 | 0/8 1/10 2/12 3/13 4/15 10/21 16/27 17/27 18/28 19/29 20/29 21/30 22/30 23/- |
| 40 | 0/8 1/10 2/12 3/14 4/15 5/17 8/20 9/22 19/32 20/32 24/36 25/36 27/38 28/38 29/39 30/39 31/40 32/40 33/- |
| 50 | 0/8 1/10 2/12 3/14 4/15 5/17 6/18 7/20 9/22 10/24 27/41 28/41 31/44 32/44 34/46 35/46 37/48 38/48 39/49 40/49 41/50 42/50 43/- |

Appendix 3A

Table 2 (continued)

Minimum contrasts 99% (two sided) Test

N = total number of trials in each sample

| N | No. of A's in Sample (1)/No. A's in Sample (2) |
|---|---|
| 60 | 0/8 1/10 2/12 3/14 4/16 5/17 6/19 8/21 9/23 11/25 12/27 19/34 20/36 24/40 25/41 26/41 34/49 35/49 38/52 39/52 42/55 43/55 45/57 46/57 47/58 48/58 49/59 50/59 51/60 52/60 53/- |
| 70 | 0/8 1/10 2/12 3/14 4/16 5/17 6/19 7/20 8/22 10/24 11/26 14/29 15/31 21/37 22/39 32/49 33/49 34/50 40/56 41/56 45/60 46/60 49/63 50/63 52/65 53/65 55/67 56/67 57/68 58/68 59/69 60/69 61/70 62/70 63/- |
| 80 | 0/8 1/10 2/12 3/14 4/16 5/18 6/19 7/21 9/23 10/25 12/27 13/29 16/32 17/34 24/41 25/43 38/56 39/56 47/64 48/64 52/68 53/68 56/71 57/71 60/74 61/74 63/76 64/76 65/77 66/77 67/78 68/78 69/79 70/79 71/80 72/80 73/- |
| 90 | 0/8 1/10 2/12 3/14 4/16 5/18 6/19 7/21 8/22 9/24 11/26 12/28 15/31 16/33 19/36 20/38 28/46 29/48 43/62 44/62 53/71 54/71 58/75 59/75 63/79 64/79 67/82 68/82 70/84 71/84 73/86 74/86 75/87 76/87 77/88 78/88 79/89 80/89 81/90 82/90 83/- |
| 100 | 0/8 1/10 2/13 3/14 4/16 5/18 6/19 7/21 8/22 9/24 10/25 11/27 14/30 15/32 18/35 19/37 23/41 24/43 33/52 34/54 47/67 48/67 58/77 59/77 64/82 65/82 69/86 70/86 74/90 75/90 77/92 78/92 80/94 81/94 83/96 84/96 85/97 86/97 88/99 89/99 90/99 91/100 92/100 93/- |

Appendix 3A

Table 2 (continued)

Minimum contrasts 99% (two sided) Test

N = total number of trials in each sample

| N | No. of A's in Sample (1)/No. of A's in Sample (2) |
|---|---|
| 150 | 0/8 1/11 2/13 3/15 4/16 5/18 6/20 7/21 8/23 9/24 10/26 |
| | 11/27 12/29 14/31 15/33 17/35 18/37 21/40 22/42 26/46 |
| | 27/48 31/52 32/54 39/61 40/63 51/74 52/76 75/99 76/99 |
| | 88/111 89/111 97/119 98/119 103/124 104/124 109/129 110/129 |
| | 114/133 115/133 118/136 119/136 122/139 123/139 125/141 126/141 |
| | 128/143 129/143 131/145 132/145 133/146 134/146 136/148 137/148 |
| | 138/149 139/149 140/150 141/150 142/150 143/- |
| 200 | 0/8 1/11 2/13 3/15 4/16 5/18 6/20 7/21 8/23 9/24 10/26 11/27 |
| | 12/29 13/30 14/32 16/34 17/36 19/38 20/40 23/43 24/45 26/47 |
| | 27/49 31/53 32/55 36/59 37/61 43/67 44/69 51/76 52/78 63/89 |
| | 64/91 110/137 111/137 123/149 124/149 132/157 133/157 140/164 |
| | 141/164 146/169 147/169 152/174 153/174 156/177 157/177 |
| | 161/181 162/181 165/184 166/184 169/187 170/187 172/189 173/189 |
| | 175/191 176/191 178/193 179/193 181/195 182/195 183/196 184/196 |
| | 186/198 187/198 188/199 189/199 190/200 191/200 192/200 193/- |
| 300 | 0/8 1/11 2/13 3/15 4/17 5/18 6/20 7/22 8/23 9/25 10/26 11/28 |
| | 12/29 13/31 15/33 16/35 17/36 18/38 20/40 21/42 23/44 24/46 |
| | 27/49 28/51 31/54 32/56 35/59 36/61 40/65 41/67 45/71 46/73 51/78 |
| | 52/80 58/86 59/88 66/95 67/97 76/106 77/108 88/119 89/121 107/139 |
| | 108/141 160/193 161/193 180/212 181/212 193/224 194/224 204/234 |
| | 205/234 213/242 214/242 221/249 222/249 228/255 229/255 234/260 |
| | 235/260 240/265 241/265 245/269 246/269 250/273 251/273 255/277 |
| | 256/277 259/280 260/280 263/283 264/283 266/285 267/285 270/288 |
| | 271/288 273/290 274/290 276/292 |

Appendix 3B

Table I

Lower Limits of Binomial confidence Intervals

(One Sided Limits)

Where C = One sided confidence levels

N = Sample size.

F = Observed number of failures in a sample of N trials.

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 5 | 0 | 0.129 | 0.275 | 0.369 | 0.450 | 0.601 | 0.653 |
| | 1 | 0.313 | 0.490 | 0.583 | 0.657 | 0.777 | 0.814 |
| | 2 | 0.500 | 0.673 | 0.753 | 0.810 | 0.894 | 0.917 |
| | 3 | 0.686 | 0.831 | 0.887 | 0.923 | 0.967 | 0.977 |
| 6 | 0 | 0.109 | 0.235 | 0.318 | 0.393 | 0.535 | 0.586 |
| | 1 | 0.264 | 0.422 | 0.510 | 0.581 | 0.705 | 0.746 |
| | 2 | 0.421 | 0.585 | 0.666 | 0.728 | 0.826 | 0.856 |
| | 3 | 0.578 | 0.731 | 0.799 | 0.846 | 0.915 | 0.933 |
| 7 | 0 | 0.094 | 0.205 | 0.280 | 0.348 | 0.482 | 0.530 |
| | 1 | 0.228 | 0.370 | 0.452 | 0.520 | 0.643 | 0.684 |
| | 2 | 0.364 | 0.516 | 0.596 | 0.658 | 0.763 | 0.797 |
| | 3 | 0.500 | 0.649 | 0.721 | 0.774 | 0.857 | 0.882 |
| | 4 | 0.635 | 0.771 | 0.830 | 0.871 | 0.929 | 0.944 |
| 8 | 0 | 0.082 | 0.182 | 0.250 | 0.312 | 0.437 | 0.484 |
| | 1 | 0.201 | 0.330 | 0.406 | 0.470 | 0.589 | 0.631 |
| | 2 | 0.320 | 0.462 | 0.538 | 0.599 | 0.706 | 0.742 |
| | 3 | 0.440 | 0.583 | 0.655 | 0.710 | 0.801 | 0.830 |
| | 4 | 0.559 | 0.696 | 0.760 | 0.807 | 0.879 | 0.900 |
| 9 | 0 | 0.074 | 0.163 | 0.225 | 0.283 | 0.400 | 0.444 |
| | 1 | 0.179 | 0.297 | 0.368 | 0.429 | 0.544 | 0.584 |
| | 2 | 0.286 | 0.417 | 0.490 | 0.549 | 0.656 | 0.692 |
| | 3 | 0.393 | 0.529 | 0.599 | 0.655 | 0.749 | 0.780 |
| | 4 | 0.500 | 0.633 | 0.699 | 0.748 | 0.829 | 0.853 |
| | 5 | 0.606 | 0.732 | 0.789 | 0.831 | 0.894 | 0.913 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 10 | 0 | 0.066 | 0.148 | 0.205 | 0.258 | 0.369 | 0.411 |
| | 1 | 0.162 | 0.270 | 0.336 | 0.394 | 0.504 | 0.544 |
| | 2 | 0.258 | 0.380 | 0.449 | 0.506 | 0.611 | 0.648 |
| | 3 | 0.355 | 0.483 | 0.551 | 0.606 | 0.702 | 0.735 |
| | 4 | 0.451 | 0.580 | 0.645 | 0.696 | 0.781 | 0.809 |
| | 5 | 0.548 | 0.673 | 0.732 | 0.777 | 0.849 | 0.871 |
| | 6 | 0.644 | 0.760 | 0.812 | 0.849 | 0.906 | 0.923 |
| 11 | 0 | 0.061 | 0.136 | 0.188 | 0.238 | 0.342 | 0.382 |
| | 1 | 0.147 | 0.248 | 0.310 | 0.364 | 0.469 | 0.508 |
| | 2 | 0.235 | 0.350 | 0.415 | 0.470 | 0.572 | 0.608 |
| | 3 | 0.323 | 0.445 | 0.510 | 0.564 | 0.660 | 0.693 |
| | 4 | 0.411 | 0.535 | 0.599 | 0.650 | 0.737 | 0.766 |
| | 5 | 0.500 | 0.622 | 0.682 | 0.728 | 0.806 | 0.830 |
| | 6 | 0.588 | 0.704 | 0.759 | 0.800 | 0.865 | 0.885 |
| 12 | 0 | 0.056 | 0.125 | 0.174 | 0.220 | 0.318 | 0.356 |
| | 1 | 0.135 | 0.229 | 0.287 | 0.338 | 0.439 | 0.477 |
| | 2 | 0.216 | 0.323 | 0.385 | 0.438 | 0.537 | 0.572 |
| | 3 | 0.297 | 0.412 | 0.475 | 0.527 | 0.622 | 0.655 |
| | 4 | 0.378 | 0.496 | 0.559 | 0.609 | 0.697 | 0.727 |
| | 5 | 0.459 | 0.577 | 0.637 | 0.684 | 0.765 | 0.791 |
| | 6 | 0.540 | 0.655 | 0.711 | 0.754 | 0.825 | 0.847 |
| | 7 | 0.621 | 0.730 | 0.781 | 0.818 | 0.878 | 0.896 |
| 13 | 0 | 0.051 | 0.116 | 0.162 | 0.205 | 0.298 | 0.334 |
| | 1 | 0.125 | 0.213 | 0.267 | 0.316 | 0.412 | 0.449 |
| | 2 | 0.200 | 0.301 | 0.359 | 0.410 | 0.506 | 0.541 |
| | 3 | 0.275 | 0.383 | 0.444 | 0.494 | 0.587 | 0.620 |
| | 4 | 0.350 | 0.463 | 0.523 | 0.572 | 0.660 | 0.691 |
| | 5 | 0.425 | 0.539 | 0.598 | 0.645 | 0.727 | 0.754 |
| | 6 | 0.500 | 0.613 | 0.669 | 0.712 | 0.787 | 0.811 |
| | 7 | 0.574 | 0.684 | 0.736 | 0.776 | 0.841 | 0.861 |
| 14 | 0 | 0.048 | 0.108 | 0.151 | 0.192 | 0.280 | 0.315 |
| | 1 | 0.117 | 0.199 | 0.250 | 0.296 | 0.389 | 0.424 |
| | 2 | 0.186 | 0.281 | 0.337 | 0.385 | 0.478 | 0.512 |
| | 3 | 0.256 | 0.359 | 0.416 | 0.465 | 0.556 | 0.589 |
| | 4 | 0.325 | 0.433 | 0.491 | 0.540 | 0.627 | 0.657 |
| | 5 | 0.395 | 0.505 | 0.563 | 0.609 | 0.692 | 0.720 |
| | 6 | 0.465 | 0.575 | 0.630 | 0.674 | 0.751 | 0.776 |
| | 7 | 0.534 | 0.642 | 0.695 | 0.736 | 0.805 | 0.827 |
| | 8 | 0.604 | 0.707 | 0.756 | 0.793 | 0.854 | 0.873 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 15 | 0 | 0.045 | 0.101 | 0.142 | 0.181 | 0.264 | 0.297 |
| | 1 | 0.109 | 0.186 | 0.235 | 0.279 | 0.367 | 0.401 |
| | 2 | 0.174 | 0.264 | 0.317 | 0.363 | 0.453 | 0.486 |
| | 3 | 0.239 | 0.337 | 0.392 | 0.439 | 0.528 | 0.560 |
| | 4 | 0.304 | 0.407 | 0.463 | 0.510 | 0.596 | 0.627 |
| | 5 | 0.369 | 0.475 | 0.531 | 0.577 | 0.659 | 0.688 |
| | 6 | 0.434 | 0.541 | 0.596 | 0.640 | 0.717 | 0.743 |
| | 7 | 0.500 | 0.605 | 0.658 | 0.700 | 0.771 | 0.794 |
| | 8 | 0.565 | 0.667 | 0.717 | 0.756 | 0.820 | 0.841 |
| | 9 | 0.630 | 0.728 | 0.774 | 0.809 | 0.865 | 0.883 |
| 16 | 0 | 0.042 | 0.095 | 0.134 | 0.170 | 0.250 | 0.281 |
| | 1 | 0.102 | 0.175 | 0.222 | 0.263 | 0.348 | 0.381 |
| | 2 | 0.163 | 0.248 | 0.299 | 0.343 | 0.430 | 0.462 |
| | 3 | 0.224 | 0.318 | 0.371 | 0.416 | 0.502 | 0.534 |
| | 4 | 0.285 | 0.384 | 0.438 | 0.484 | 0.568 | 0.599 |
| | 5 | 0.347 | 0.448 | 0.503 | 0.548 | 0.629 | 0.658 |
| | 6 | 0.408 | 0.511 | 0.565 | 0.608 | 0.686 | 0.713 |
| | 7 | 0.469 | 0.572 | 0.624 | 0.666 | 0.739 | 0.763 |
| | 8 | 0.530 | 0.631 | 0.682 | 0.721 | 0.788 | 0.810 |
| | 9 | 0.591 | 0.689 | 0.737 | 0.773 | 0.833 | 0.852 |
| 17 | 0 | 0.039 | 0.090 | 0.126 | 0.161 | 0.237 | 0.267 |
| | 1 | 0.096 | 0.166 | 0.210 | 0.250 | 0.331 | 0.363 |
| | 2 | 0.154 | 0.235 | 0.283 | 0.326 | 0.409 | 0.441 |
| | 3 | 0.211 | 0.300 | 0.351 | 0.395 | 0.479 | 0.510 |
| | 4 | 0.269 | 0.363 | 0.416 | 0.460 | 0.543 | 0.573 |
| | 5 | 0.327 | 0.425 | 0.478 | 0.521 | 0.602 | 0.630 |
| | 6 | 0.384 | 0.484 | 0.537 | 0.580 | 0.657 | 0.684 |
| | 7 | 0.442 | 0.542 | 0.594 | 0.635 | 0.709 | 0.734 |
| | 8 | 0.500 | 0.599 | 0.649 | 0.689 | 0.757 | 0.780 |
| | 9 | 0.557 | 0.655 | 0.702 | 0.739 | 0.802 | 0.823 |
| | 10 | 0.615 | 0.709 | 0.753 | 0.788 | 0.844 | 0.862 |
| 18 | 0 | 0.037 | 0.085 | 0.120 | 0.153 | 0.225 | 0.254 |
| | 1 | 0.091 | 0.157 | 0.199 | 0.237 | 0.316 | 0.346 |
| | 2 | 0.145 | 0.223 | 0.269 | 0.310 | 0.391 | 0.421 |
| | 3 | 0.200 | 0.285 | 0.334 | 0.376 | 0.458 | 0.488 |
| | 4 | 0.254 | 0.345 | 0.396 | 0.438 | 0.519 | 0.549 |
| | 5 | 0.309 | 0.403 | 0.455 | 0.497 | 0.577 | 0.605 |
| | 6 | 0.363 | 0.460 | 0.511 | 0.554 | 0.630 | 0.657 |
| | 7 | 0.418 | 0.515 | 0.566 | 0.607 | 0.681 | 0.706 |
| | 8 | 0.472 | 0.570 | 0.619 | 0.659 | 0.728 | 0.752 |
| | 9 | 0.527 | 0.623 | 0.671 | 0.708 | 0.773 | 0.795 |
| | 10 | 0.581 | 0.675 | 0.720 | 0.756 | 0.815 | 0.835 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 19 | 0 | 0.035 | 0.081 | 0.114 | 0.145 | 0.215 | 0.243 |
| | 1 | 0.086 | 0.149 | 0.189 | 0.226 | 0.301 | 0.331 |
| | 2 | 0.138 | 0.211 | 0.256 | 0.295 | 0.374 | 0.403 |
| | 3 | 0.189 | 0.271 | 0.318 | 0.359 | 0.438 | 0.468 |
| | 4 | 0.241 | 0.328 | 0.377 | 0.419 | 0.498 | 0.527 |
| | 5 | 0.293 | 0.384 | 0.434 | 0.475 | 0.553 | 0.581 |
| | 6 | 0.344 | 0.438 | 0.488 | 0.529 | 0.606 | 0.632 |
| | 7 | 0.396 | 0.491 | 0.541 | 0.581 | 0.655 | 0.680 |
| | 8 | 0.448 | 0.543 | 0.592 | 0.631 | 0.701 | 0.726 |
| | 9 | 0.500 | 0.594 | 0.642 | 0.679 | 0.746 | 0.768 |
| | 10 | 0.551 | 0.644 | 0.690 | 0.726 | 0.787 | 0.808 |
| | 11 | 0.603 | 0.693 | 0.736 | 0.770 | 0.826 | 0.845 |
| 20 | 0 | 0.034 | 0.077 | 0.108 | 0.139 | 0.205 | 0.232 |
| | 1 | 0.082 | 0.142 | 0.180 | 0.216 | 0.288 | 0.317 |
| | 2 | 0.131 | 0.202 | 0.244 | 0.282 | 0.358 | 0.387 |
| | 3 | 0.180 | 0.258 | 0.304 | 0.343 | 0.420 | 0.449 |
| | 4 | 0.229 | 0.313 | 0.360 | 0.401 | 0.478 | 0.506 |
| | 5 | 0.278 | 0.366 | 0.414 | 0.455 | 0.532 | 0.559 |
| | 6 | 0.327 | 0.418 | 0.467 | 0.507 | 0.582 | 0.609 |
| | 7 | 0.377 | 0.469 | 0.518 | 0.558 | 0.630 | 0.656 |
| | 8 | 0.426 | 0.519 | 0.567 | 0.606 | 0.676 | 0.700 |
| | 9 | 0.475 | 0.568 | 0.615 | 0.653 | 0.719 | 0.742 |
| | 10 | 0.524 | 0.616 | 0.661 | 0.698 | 0.761 | 0.782 |
| | 11 | 0.573 | 0.663 | 0.707 | 0.741 | 0.799 | 0.819 |
| | 12 | 0.622 | 0.709 | 0.750 | 0.782 | 0.836 | 0.854 |
| 21 | 0 | 0.032 | 0.073 | 0.103 | 0.132 | 0.196 | 0.222 |
| | 1 | 0.078 | 0.135 | 0.172 | 0.206 | 0.276 | 0.304 |
| | 2 | 0.125 | 0.192 | 0.234 | 0.270 | 0.343 | 0.371 |
| | 3 | 0.172 | 0.247 | 0.291 | 0.329 | 0.404 | 0.432 |
| | 4 | 0.218 | 0.299 | 0.345 | 0.384 | 0.459 | 0.487 |
| | 5 | 0.265 | 0.350 | 0.397 | 0.436 | 0.511 | 0.539 |
| | 6 | 0.312 | 0.400 | 0.447 | 0.487 | 0.561 | 0.587 |
| | 7 | 0.359 | 0.448 | 0.496 | 0.535 | 0.608 | 0.633 |
| | 8 | 0.406 | 0.496 | 0.544 | 0.582 | 0.652 | 0.677 |
| | 9 | 0.453 | 0.543 | 0.590 | 0.628 | 0.695 | 0.718 |
| | 10 | 0.500 | 0.590 | 0.635 | 0.671 | 0.735 | 0.757 |
| | 11 | 0.546 | 0.635 | 0.679 | 0.714 | 0.774 | 0.794 |
| | 12 | 0.593 | 0.680 | 0.722 | 0.755 | 0.810 | 0.829 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 22 | 0 | 0.031 | 0.070 | 0.099 | 0.127 | 0.188 | 0.214 |
| | 1 | 0.075 | 0.130 | 0.165 | 0.198 | 0.265 | 0.292 |
| | 2 | 0.119 | 0.184 | 0.224 | 0.259 | 0.330 | 0.357 |
| | 3 | 0.164 | 0.236 | 0.278 | 0.315 | 0.388 | 0.416 |
| | 4 | 0.209 | 0.286 | 0.331 | 0.369 | 0.442 | 0.469 |
| | 5 | 0.253 | 0.335 | 0.381 | 0.419 | 0.493 | 0.520 |
| | 6 | 0.298 | 0.383 | 0.429 | 0.468 | 0.541 | 0.567 |
| | 7 | 0.343 | 0.430 | 0.476 | 0.515 | 0.586 | 0.612 |
| | 8 | 0.388 | 0.476 | 0.522 | 0.560 | 0.630 | 0.654 |
| | 9 | 0.432 | 0.521 | 0.567 | 0.604 | 0.672 | 0.695 |
| | 10 | 0.477 | 0.566 | 0.611 | 0.647 | 0.711 | 0.734 |
| | 11 | 0.522 | 0.609 | 0.653 | 0.688 | 0.749 | 0.770 |
| | 12 | 0.567 | 0.652 | 0.695 | 0.728 | 0.786 | 0.805 |
| | 13 | 0.611 | 0.695 | 0.735 | 0.767 | 0.820 | 0.838 |
| 23 | 0 | 0.029 | 0.067 | 0.095 | 0.122 | 0.181 | 0.205 |
| | 1 | 0.071 | 0.124 | 0.158 | 0.190 | 0.255 | 0.281 |
| | 2 | 0.114 | 0.176 | 0.215 | 0.249 | 0.318 | 0.344 |
| | 3 | 0.157 | 0.226 | 0.267 | 0.303 | 0.374 | 0.401 |
| | 4 | 0.200 | 0.275 | 0.317 | 0.354 | 0.426 | 0.453 |
| | 5 | 0.242 | 0.321 | 0.366 | 0.403 | 0.475 | 0.502 |
| | 6 | 0.285 | 0.367 | 0.413 | 0.450 | 0.522 | 0.548 |
| | 7 | 0.328 | 0.412 | 0.458 | 0.496 | 0.566 | 0.592 |
| | 8 | 0.371 | 0.457 | 0.502 | 0.540 | 0.609 | 0.633 |
| | 9 | 0.414 | 0.500 | 0.546 | 0.583 | 0.650 | 0.673 |
| | 10 | 0.457 | 0.543 | 0.588 | 0.624 | 0.689 | 0.711 |
| | 11 | 0.500 | 0.586 | 0.629 | 0.664 | 0.726 | 0.747 |
| | 12 | 0.542 | 0.627 | 0.670 | 0.703 | 0.762 | 0.782 |
| | 13 | 0.585 | 0.668 | 0.709 | 0.741 | 0.796 | 0.815 |
| 24 | 0 | 0.028 | 0.064 | 0.091 | 0.117 | 0.174 | 0.198 |
| | 1 | 0.068 | 0.119 | 0.152 | 0.182 | 0.246 | 0.271 |
| | 2 | 0.109 | 0.169 | 0.206 | 0.239 | 0.306 | 0.332 |
| | 3 | 0.150 | 0.217 | 0.257 | 0.292 | 0.361 | 0.387 |
| | 4 | 0.191 | 0.264 | 0.305 | 0.341 | 0.411 | 0.437 |
| | 5 | 0.232 | 0.309 | 0.352 | 0.389 | 0.459 | 0.485 |
| | 6 | 0.274 | 0.353 | 0.397 | 0.434 | 0.504 | 0.530 |
| | 7 | 0.315 | 0.397 | 0.441 | 0.478 | 0.548 | 0.573 |
| | 8 | 0.356 | 0.439 | 0.484 | 0.521 | 0.589 | 0.613 |
| | 9 | 0.397 | 0.481 | 0.526 | 0.562 | 0.629 | 0.653 |
| | 10 | 0.438 | 0.523 | 0.567 | 0.603 | 0.667 | 0.690 |
| | 11 | 0.479 | 0.564 | 0.607 | 0.642 | 0.704 | 0.726 |
| | 12 | 0.520 | 0.604 | 0.646 | 0.680 | 0.740 | 0.760 |
| | 13 | 0.561 | 0.644 | 0.685 | 0.717 | 0.774 | 0.793 |
| | 14 | 0.602 | 0.683 | 0.722 | 0.753 | 0.806 | 0.824 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 25 | 0 | 0.027 | 0.062 | 0.087 | 0.112 | 0.168 | 0.190 |
| | 1 | 0.066 | 0.115 | 0.146 | 0.176 | 0.237 | 0.261 |
| | 2 | 0.105 | 0.163 | 0.199 | 0.231 | 0.295 | 0.321 |
| | 3 | 0.144 | 0.209 | 0.248 | 0.281 | 0.348 | 0.374 |
| | 4 | 0.184 | 0.254 | 0.294 | 0.329 | 0.397 | 0.423 |
| | 5 | 0.223 | 0.297 | 0.339 | 0.375 | 0.444 | 0.469 |
| | 6 | 0.263 | 0.340 | 0.383 | 0.419 | 0.488 | 0.513 |
| | 7 | 0.302 | 0.382 | 0.425 | 0.462 | 0.530 | 0.555 |
| | 8 | 0.342 | 0.423 | 0.467 | 0.503 | 0.571 | 0.595 |
| | 9 | 0.381 | 0.464 | 0.507 | 0.543 | 0.610 | 0.633 |
| | 10 | 0.421 | 0.504 | 0.547 | 0.583 | 0.647 | 0.670 |
| | 11 | 0.460 | 0.543 | 0.586 | 0.621 | 0.683 | 0.705 |
| | 12 | 0.500 | 0.582 | 0.624 | 0.658 | 0.718 | 0.739 |
| | 13 | 0.539 | 0.621 | 0.662 | 0.694 | 0.752 | 0.771 |
| | 14 | 0.578 | 0.659 | 0.698 | 0.730 | 0.784 | 0.802 |
| | 15 | 0.618 | 0.696 | 0.734 | 0.764 | 0.815 | 0.832 |
| 26 | 0 | 0.026 | 0.060 | 0.084 | 0.108 | 0.162 | 0.184 |
| | 1 | 0.063 | 0.110 | 0.141 | 0.169 | 0.229 | 0.252 |
| | 2 | 0.101 | 0.157 | 0.191 | 0.222 | 0.285 | 0.310 |
| | 3 | 0.139 | 0.201 | 0.239 | 0.271 | 0.337 | 0.362 |
| | 4 | 0.177 | 0.245 | 0.284 | 0.318 | 0.384 | 0.409 |
| | 5 | 0.215 | 0.287 | 0.327 | 0.362 | 0.429 | 0.455 |
| | 6 | 0.253 | 0.328 | 0.369 | 0.405 | 0.472 | 0.497 |
| | 7 | 0.291 | 0.368 | 0.411 | 0.446 | 0.514 | 0.538 |
| | 8 | 0.329 | 0.408 | 0.451 | 0.487 | 0.553 | 0.577 |
| | 9 | 0.367 | 0.447 | 0.490 | 0.526 | 0.591 | 0.615 |
| | 10 | 0.405 | 0.486 | 0.529 | 0.564 | 0.628 | 0.651 |
| | 11 | 0.443 | 0.524 | 0.567 | 0.601 | 0.663 | 0.685 |
| | 12 | 0.481 | 0.562 | 0.604 | 0.637 | 0.698 | 0.719 |
| | 13 | 0.518 | 0.599 | 0.640 | 0.673 | 0.731 | 0.751 |
| | 14 | 0.556 | 0.636 | 0.676 | 0.707 | 0.763 | 0.781 |
| | 15 | 0.594 | 0.672 | 0.711 | 0.741 | 0.793 | 0.811 |
| 27 | 0 | 0.025 | 0.057 | 0.081 | 0.105 | 0.156 | 0.178 |
| | 1 | 0.061 | 0.106 | 0.136 | 0.163 | 0.221 | 0.244 |
| | 2 | 0.097 | 0.151 | 0.185 | 0.215 | 0.276 | 0.300 |
| | 3 | 0.134 | 0.194 | 0.230 | 0.262 | 0.326 | 0.350 |
| | 4 | 0.170 | 0.236 | 0.274 | 0.307 | 0.372 | 0.397 |
| | 5 | 0.207 | 0.277 | 0.316 | 0.350 | 0.416 | 0.441 |
| | 6 | 0.243 | 0.316 | 0.357 | 0.392 | 0.458 | 0.482 |
| | 7 | 0.280 | 0.355 | 0.397 | 0.432 | 0.498 | 0.522 |
| | 8 | 0.317 | 0.394 | 0.436 | 0.471 | 0.537 | 0.560 |
| | 9 | 0.353 | 0.432 | 0.474 | 0.509 | 0.574 | 0.597 |
| | 10 | 0.390 | 0.469 | 0.512 | 0.546 | 0.610 | 0.632 |
| | 11 | 0.426 | 0.506 | 0.548 | 0.582 | 0.645 | 0.666 |
| | 12 | 0.463 | 0.543 | 0.584 | 0.618 | 0.678 | 0.699 |
| | 13 | 0.500 | 0.579 | 0.620 | 0.653 | 0.711 | 0.731 |
| | 14 | 0.536 | 0.615 | 0.655 | 0.686 | 0.742 | 0.761 |
| | 15 | 0.573 | 0.650 | 0.689 | 0.719 | 0.773 | 0.791 |
| | 16 | 0.609 | 0.685 | 0.722 | 0.752 | 0.802 | 0.819 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 28 | 0 | 0.024 | 0.055 | 0.078 | 0.101 | 0.151 | 0.172 |
| | 1 | 0.059 | 0.103 | 0.131 | 0.158 | 0.214 | 0.236 |
| | 2 | 0.094 | 0.146 | 0.179 | 0.208 | 0.267 | 0.291 |
| | 3 | 0.129 | 0.188 | 0.223 | 0.254 | 0.316 | 0.339 |
| | 4 | 0.164 | 0.228 | 0.265 | 0.297 | 0.361 | 0.385 |
| | 5 | 0.200 | 0.267 | 0.306 | 0.339 | 0.403 | 0.428 |
| | 6 | 0.235 | 0.306 | 0.345 | 0.379 | 0.444 | 0.468 |
| | 7 | 0.270 | 0.344 | 0.384 | 0.418 | 0.483 | 0.507 |
| | 8 | 0.305 | 0.381 | 0.422 | 0.456 | 0.521 | 0.544 |
| | 9 | 0.341 | 0.418 | 0.459 | 0.493 | 0.557 | 0.580 |
| | 10 | 0.376 | 0.454 | 0.495 | 0.529 | 0.593 | 0.615 |
| | 11 | 0.411 | 0.490 | 0.531 | 0.565 | 0.627 | 0.649 |
| | 12 | 0.447 | 0.525 | 0.566 | 0.599 | 0.660 | 0.681 |
| | 13 | 0.482 | 0.560 | 0.601 | 0.633 | 0.692 | 0.712 |
| | 14 | 0.517 | 0.595 | 0.635 | 0.666 | 0.723 | 0.742 |
| | 15 | 0.552 | 0.629 | 0.668 | 0.699 | 0.753 | 0.771 |
| | 16 | 0.588 | 0.663 | 0.701 | 0.730 | 0.782 | 0.799 |
| 29 | 0 | 0.023 | 0.053 | 0.076 | 0.098 | 0.146 | 0.166 |
| | 1 | 0.057 | 0.099 | 0.127 | 0.153 | 0.207 | 0.229 |
| | 2 | 0.091 | 0.141 | 0.173 | 0.201 | 0.259 | 0.282 |
| | 3 | 0.125 | 0.182 | 0.216 | 0.246 | 0.306 | 0.329 |
| | 4 | 0.159 | 0.220 | 0.256 | 0.288 | 0.350 | 0.374 |
| | 5 | 0.193 | 0.258 | 0.296 | 0.328 | 0.392 | 0.415 |
| | 6 | 0.227 | 0.296 | 0.334 | 0.368 | 0.431 | 0.455 |
| | 7 | 0.261 | 0.332 | 0.372 | 0.405 | 0.469 | 0.493 |
| | 8 | 0.295 | 0.369 | 0.409 | 0.442 | 0.506 | 0.529 |
| | 9 | 0.329 | 0.404 | 0.445 | 0.479 | 0.542 | 0.565 |
| | 10 | 0.363 | 0.439 | 0.480 | 0.514 | 0.576 | 0.599 |
| | 11 | 0.397 | 0.474 | 0.515 | 0.548 | 0.610 | 0.631 |
| | 12 | 0.431 | 0.509 | 0.549 | 0.582 | 0.642 | 0.663 |
| | 13 | 0.465 | 0.543 | 0.583 | 0.615 | 0.674 | 0.694 |
| | 14 | 0.500 | 0.577 | 0.616 | 0.648 | 0.704 | 0.724 |
| | 15 | 0.534 | 0.610 | 0.648 | 0.679 | 0.734 | 0.753 |
| | 16 | 0.568 | 0.643 | 0.680 | 0.710 | 0.763 | 0.780 |
| | 17 | 0.602 | 0.676 | 0.712 | 0.741 | 0.790 | 0.807 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 30 | 0 | 0.022 | 0.052 | 0.073 | 0.095 | 0.142 | 0.161 |
| | 1 | 0.055 | 0.096 | 0.123 | 0.148 | 0.201 | 0.222 |
| | 2 | 0.088 | 0.137 | 0.167 | 0.195 | 0.251 | 0.274 |
| | 3 | 0.121 | 0.176 | 0.209 | 0.238 | 0.297 | 0.320 |
| | 4 | 0.153 | 0.213 | 0.248 | 0.279 | 0.340 | 0.363 |
| | 5 | 0.186 | 0.250 | 0.287 | 0.318 | 0.380 | 0.404 |
| | 6 | 0.219 | 0.286 | 0.324 | 0.357 | 0.419 | 0.442 |
| | 7 | 0.252 | 0.322 | 0.361 | 0.393 | 0.456 | 0.479 |
| | 8 | 0.285 | 0.357 | 0.396 | 0.429 | 0.492 | 0.515 |
| | 9 | 0.318 | 0.392 | 0.431 | 0.465 | 0.527 | 0.550 |
| | 10 | 0.351 | 0.426 | 0.466 | 0.499 | 0.561 | 0.583 |
| | 11 | 0.384 | 0.460 | 0.500 | 0.533 | 0.593 | 0.615 |
| | 12 | 0.417 | 0.493 | 0.533 | 0.566 | 0.625 | 0.646 |
| | 13 | 0.450 | 0.526 | 0.566 | 0.598 | 0.656 | 0.677 |
| | 14 | 0.483 | 0.559 | 0.598 | 0.630 | 0.686 | 0.706 |
| | 15 | 0.516 | 0.591 | 0.630 | 0.661 | 0.716 | 0.735 |
| | 16 | 0.549 | 0.624 | 0.661 | 0.691 | 0.744 | 0.762 |
| | 17 | 0.582 | 0.655 | 0.692 | 0.721 | 0.772 | 0.789 |
| | 18 | 0.615 | 0.687 | 0.722 | 0.750 | 0.798 | 0.814 |
| 31 | 0 | 0.022 | 0.050 | 0.071 | 0.092 | 0.138 | 0.157 |
| | 1 | 0.053 | 0.093 | 0.119 | 0.144 | 0.195 | 0.216 |
| | 2 | 0.085 | 0.133 | 0.162 | 0.189 | 0.244 | 0.266 |
| | 3 | 0.117 | 0.170 | 0.202 | 0.231 | 0.289 | 0.311 |
| | 4 | 0.149 | 0.207 | 0.241 | 0.271 | 0.330 | 0.353 |
| | 5 | 0.180 | 0.243 | 0.278 | 0.309 | 0.370 | 0.392 |
| | 6 | 0.212 | 0.278 | 0.315 | 0.346 | 0.407 | 0.430 |
| | 7 | 0.244 | 0.312 | 0.350 | 0.382 | 0.444 | 0.467 |
| | 8 | 0.276 | 0.346 | 0.385 | 0.417 | 0.479 | 0.502 |
| | 9 | 0.308 | 0.380 | 0.419 | 0.451 | 0.513 | 0.535 |
| | 10 | 0.340 | 0.413 | 0.452 | 0.485 | 0.546 | 0.568 |
| | 11 | 0.372 | 0.446 | 0.485 | 0.518 | 0.578 | 0.600 |
| | 12 | 0.404 | 0.478 | 0.518 | 0.550 | 0.609 | 0.630 |
| | 13 | 0.436 | 0.511 | 0.550 | 0.582 | 0.640 | 0.660 |
| | 14 | 0.468 | 0.542 | 0.581 | 0.613 | 0.669 | 0.689 |
| | 15 | 0.500 | 0.574 | 0.612 | 0.643 | 0.698 | 0.717 |
| | 16 | 0.531 | 0.605 | 0.643 | 0.673 | 0.726 | 0.745 |
| | 17 | 0.563 | 0.636 | 0.673 | 0.702 | 0.753 | 0.771 |
| | 18 | 0.595 | 0.667 | 0.703 | 0.731 | 0.780 | 0.797 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 32 | 0 | 0.021 | 0.049 | 0.069 | 0.089 | 0.134 | 0.152 |
| | 1 | 0.051 | 0.090 | 0.116 | 0.139 | 0.190 | 0.210 |
| | 2 | 0.082 | 0.129 | 0.157 | 0.183 | 0.237 | 0.258 |
| | 3 | 0.113 | 0.165 | 0.196 | 0.224 | 0.281 | 0.302 |
| | 4 | 0.144 | 0.201 | 0.234 | 0.263 | 0.321 | 0.343 |
| | 5 | 0.175 | 0.235 | 0.270 | 0.300 | 0.360 | 0.382 |
| | 6 | 0.206 | 0.269 | 0.305 | 0.336 | 0.397 | 0.419 |
| | 7 | 0.237 | 0.303 | 0.340 | 0.371 | 0.432 | 0.454 |
| | 8 | 0.268 | 0.336 | 0.374 | 0.406 | 0.466 | 0.489 |
| | 9 | 0.299 | 0.369 | 0.407 | 0.439 | 0.500 | 0.522 |
| | 10 | 0.329 | 0.401 | 0.439 | 0.472 | 0.532 | 0.554 |
| | 11 | 0.360 | 0.433 | 0.472 | 0.504 | 0.563 | 0.585 |
| | 12 | 0.391 | 0.465 | 0.503 | 0.535 | 0.594 | 0.615 |
| | 13 | 0.422 | 0.496 | 0.534 | 0.566 | 0.624 | 0.644 |
| | 14 | 0.453 | 0.527 | 0.565 | 0.596 | 0.653 | 0.673 |
| | 15 | 0.484 | 0.558 | 0.595 | 0.626 | 0.681 | 0.701 |
| | 16 | 0.515 | 0.588 | 0.625 | 0.655 | 0.709 | 0.728 |
| | 17 | 0.546 | 0.618 | 0.655 | 0.684 | 0.736 | 0.754 |
| | 18 | 0.577 | 0.648 | 0.684 | 0.712 | 0.762 | 0.779 |
| | 19 | 0.608 | 0.678 | 0.712 | 0.740 | 0.788 | 0.804 |
| 33 | 0 | 0.020 | 0.047 | 0.067 | 0.086 | 0.130 | 0.148 |
| | 1 | 0.050 | 0.088 | 0.112 | 0.135 | 0.184 | 0.204 |
| | 2 | 0.080 | 0.125 | 0.153 | 0.178 | 0.231 | 0.251 |
| | 3 | 0.110 | 0.160 | 0.191 | 0.218 | 0.273 | 0.294 |
| | 4 | 0.140 | 0.195 | 0.227 | 0.256 | 0.313 | 0.334 |
| | 5 | 0.170 | 0.229 | 0.263 | 0.292 | 0.350 | 0.372 |
| | 6 | 0.200 | 0.262 | 0.297 | 0.327 | 0.386 | 0.408 |
| | 7 | 0.230 | 0.294 | 0.330 | 0.361 | 0.421 | 0.443 |
| | 8 | 0.260 | 0.326 | 0.363 | 0.395 | 0.454 | 0.476 |
| | 9 | 0.290 | 0.358 | 0.396 | 0.427 | 0.487 | 0.509 |
| | 10 | 0.320 | 0.390 | 0.427 | 0.459 | 0.519 | 0.540 |
| | 11 | 0.350 | 0.421 | 0.459 | 0.490 | 0.549 | 0.571 |
| | 12 | 0.380 | 0.451 | 0.490 | 0.521 | 0.579 | 0.600 |
| | 13 | 0.410 | 0.482 | 0.520 | 0.551 | 0.609 | 0.629 |
| | 14 | 0.440 | 0.512 | 0.550 | 0.581 | 0.637 | 0.657 |
| | 15 | 0.470 | 0.542 | 0.580 | 0.610 | 0.665 | 0.685 |
| | 16 | 0.500 | 0.572 | 0.609 | 0.639 | 0.693 | 0.711 |
| | 17 | 0.530 | 0.601 | 0.638 | 0.667 | 0.719 | 0.737 |
| | 18 | 0.559 | 0.630 | 0.666 | 0.695 | 0.745 | 0.762 |
| | 19 | 0.589 | 0.659 | 0.694 | 0.722 | 0.770 | 0.787 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 34 | 0 | 0.020 | 0.046 | 0.065 | 0.084 | 0.126 | 0.144 |
| | 1 | 0.048 | 0.085 | 0.109 | 0.132 | 0.179 | 0.198 |
| | 2 | 0.077 | 0.121 | 0.149 | 0.173 | 0.225 | 0.245 |
| | 3 | 0.106 | 0.156 | 0.186 | 0.212 | 0.266 | 0.287 |
| | 4 | 0.136 | 0.189 | 0.221 | 0.249 | 0.304 | 0.326 |
| | 5 | 0.165 | 0.222 | 0.255 | 0.284 | 0.341 | 0.363 |
| | 6 | 0.194 | 0.254 | 0.289 | 0.318 | 0.376 | 0.398 |
| | 7 | 0.223 | 0.286 | 0.321 | 0.352 | 0.410 | 0.432 |
| | 8 | 0.252 | 0.317 | 0.353 | 0.384 | 0.443 | 0.465 |
| | 9 | 0.281 | 0.348 | 0.385 | 0.416 | 0.475 | 0.497 |
| | 10 | 0.310 | 0.379 | 0.416 | 0.447 | 0.506 | 0.527 |
| | 11 | 0.339 | 0.409 | 0.447 | 0.478 | 0.536 | 0.557 |
| | 12 | 0.368 | 0.439 | 0.477 | 0.508 | 0.566 | 0.586 |
| | 13 | 0.398 | 0.469 | 0.506 | 0.537 | 0.594 | 0.615 |
| | 14 | 0.427 | 0.498 | 0.536 | 0.566 | 0.623 | 0.643 |
| | 15 | 0.456 | 0.527 | 0.565 | 0.595 | 0.650 | 0.669 |
| | 16 | 0.485 | 0.556 | 0.593 | 0.623 | 0.677 | 0.696 |
| | 17 | 0.514 | 0.585 | 0.621 | 0.651 | 0.703 | 0.721 |
| | 18 | 0.543 | 0.614 | 0.649 | 0.678 | 0.729 | 0.746 |
| | 19 | 0.572 | 0.642 | 0.677 | 0.704 | 0.754 | 0.770 |
| | 20 | 0.601 | 0.670 | 0.704 | 0.731 | 0.778 | 0.794 |
| 35 | 0 | 0.019 | 0.044 | 0.063 | 0.082 | 0.123 | 0.140 |
| | 1 | 0.047 | 0.083 | 0.106 | 0.128 | 0.175 | 0.193 |
| | 2 | 0.075 | 0.118 | 0.144 | 0.169 | 0.219 | 0.238 |
| | 3 | 0.103 | 0.151 | 0.181 | 0.206 | 0.259 | 0.279 |
| | 4 | 0.132 | 0.184 | 0.215 | 0.242 | 0.297 | 0.318 |
| | 5 | 0.160 | 0.216 | 0.248 | 0.277 | 0.332 | 0.354 |
| | 6 | 0.188 | 0.247 | 0.281 | 0.310 | 0.367 | 0.388 |
| | 7 | 0.217 | 0.278 | 0.313 | 0.343 | 0.400 | 0.421 |
| | 8 | 0.245 | 0.309 | 0.344 | 0.374 | 0.432 | 0.454 |
| | 9 | 0.273 | 0.339 | 0.375 | 0.405 | 0.463 | 0.485 |
| | 10 | 0.301 | 0.369 | 0.405 | 0.436 | 0.494 | 0.515 |
| | 11 | 0.330 | 0.398 | 0.435 | 0.466 | 0.523 | 0.544 |
| | 12 | 0.358 | 0.427 | 0.464 | 0.495 | 0.552 | 0.573 |
| | 13 | 0.386 | 0.456 | 0.493 | 0.524 | 0.581 | 0.601 |
| | 14 | 0.415 | 0.485 | 0.522 | 0.552 | 0.608 | 0.628 |
| | 15 | 0.443 | 0.513 | 0.550 | 0.580 | 0.635 | 0.655 |
| | 16 | 0.471 | 0.542 | 0.578 | 0.608 | 0.662 | 0.681 |
| | 17 | 0.500 | 0.570 | 0.606 | 0.635 | 0.687 | 0.706 |
| | 18 | 0.528 | 0.598 | 0.633 | 0.662 | 0.713 | 0.731 |
| | 19 | 0.556 | 0.625 | 0.660 | 0.688 | 0.737 | 0.755 |
| | 20 | 0.584 | 0.653 | 0.687 | 0.714 | 0.761 | 0.778 |
| | 21 | 0.613 | 0.680 | 0.713 | 0.739 | 0.785 | 0.801 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 36 | 0 | 0.019 | 0.043 | 0.061 | 0.079 | 0.120 | 0.136 |
| | 1 | 0.046 | 0.080 | 0.103 | 0.125 | 0.170 | 0.188 |
| | 2 | 0.073 | 0.115 | 0.141 | 0.164 | 0.213 | 0.232 |
| | 3 | 0.101 | 0.147 | 0.176 | 0.201 | 0.252 | 0.272 |
| | 4 | 0.128 | 0.179 | 0.209 | 0.236 | 0.289 | 0.310 |
| | 5 | 0.156 | 0.210 | 0.242 | 0.270 | 0.324 | 0.345 |
| | 6 | 0.183 | 0.241 | 0.274 | 0.302 | 0.358 | 0.379 |
| | 7 | 0.211 | 0.271 | 0.305 | 0.334 | 0.390 | 0.412 |
| | 8 | 0.238 | 0.301 | 0.335 | 0.365 | 0.422 | 0.443 |
| | 9 | 0.266 | 0.330 | 0.365 | 0.395 | 0.452 | 0.474 |
| | 10 | 0.293 | 0.359 | 0.395 | 0.425 | 0.482 | 0.503 |
| | 11 | 0.321 | 0.388 | 0.424 | 0.454 | 0.511 | 0.532 |
| | 12 | 0.348 | 0.416 | 0.453 | 0.483 | 0.540 | 0.560 |
| | 13 | 0.376 | 0.444 | 0.481 | 0.511 | 0.567 | 0.588 |
| | 14 | 0.403 | 0.472 | 0.509 | 0.539 | 0.595 | 0.614 |
| | 15 | 0.431 | 0.500 | 0.537 | 0.566 | 0.621 | 0.641 |
| | 16 | 0.458 | 0.528 | 0.564 | 0.593 | 0.647 | 0.666 |
| | 17 | 0.486 | 0.555 | 0.591 | 0.620 | 0.673 | 0.691 |
| | 18 | 0.513 | 0.582 | 0.618 | 0.646 | 0.697 | 0.715 |
| | 19 | 0.541 | 0.609 | 0.644 | 0.672 | 0.722 | 0.739 |
| | 20 | 0.568 | 0.636 | 0.670 | 0.697 | 0.746 | 0.762 |
| | 21 | 0.596 | 0.663 | 0.696 | 0.722 | 0.769 | 0.785 |
| 37 | 0 | 0.018 | 0.042 | 0.060 | 0.077 | 0.117 | 0.133 |
| | 1 | 0.044 | 0.078 | 0.101 | 0.121 | 0.166 | 0.184 |
| | 2 | 0.071 | 0.112 | 0.137 | 0.160 | 0.208 | 0.227 |
| | 3 | 0.098 | 0.144 | 0.171 | 0.196 | 0.246 | 0.266 |
| | 4 | 0.125 | 0.174 | 0.204 | 0.230 | 0.282 | 0.302 |
| | 5 | 0.151 | 0.205 | 0.236 | 0.263 | 0.317 | 0.337 |
| | 6 | 0.178 | 0.235 | 0.267 | 0.295 | 0.349 | 0.370 |
| | 7 | 0.205 | 0.264 | 0.297 | 0.326 | 0.381 | 0.402 |
| | 8 | 0.232 | 0.293 | 0.327 | 0.356 | 0.412 | 0.433 |
| | 9 | 0.258 | 0.321 | 0.356 | 0.386 | 0.442 | 0.463 |
| | 10 | 0.285 | 0.350 | 0.385 | 0.415 | 0.471 | 0.492 |
| | 11 | 0.312 | 0.378 | 0.413 | 0.443 | 0.500 | 0.520 |
| | 12 | 0.339 | 0.406 | 0.441 | 0.471 | 0.527 | 0.548 |
| | 13 | 0.366 | 0.433 | 0.469 | 0.499 | 0.555 | 0.575 |
| | 14 | 0.392 | 0.461 | 0.497 | 0.526 | 0.581 | 0.601 |
| | 15 | 0.419 | 0.488 | 0.524 | 0.553 | 0.608 | 0.627 |
| | 16 | 0.446 | 0.515 | 0.550 | 0.580 | 0.633 | 0.652 |
| | 17 | 0.473 | 0.541 | 0.577 | 0.606 | 0.658 | 0.677 |
| | 18 | 0.500 | 0.568 | 0.603 | 0.631 | 0.683 | 0.701 |
| | 19 | 0.526 | 0.594 | 0.629 | 0.657 | 0.707 | 0.724 |
| | 20 | 0.553 | 0.620 | 0.654 | 0.682 | 0.730 | 0.747 |
| | 21 | 0.580 | 0.646 | 0.680 | 0.706 | 0.753 | 0.770 |
| | 22 | 0.607 | 0.672 | 0.705 | 0.730 | 0.776 | 0.791 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 38 | 0 | 0.018 | 0.041 | 0.058 | 0.075 | 0.114 | 0.130 |
| | 1 | 0.043 | 0.076 | 0.098 | 0.118 | 0.162 | 0.179 |
| | 2 | 0.069 | 0.109 | 0.134 | 0.156 | 0.203 | 0.221 |
| | 3 | 0.095 | 0.140 | 0.167 | 0.191 | 0.240 | 0.260 |
| | 4 | 0.121 | 0.170 | 0.199 | 0.224 | 0.276 | 0.295 |
| | 5 | 0.147 | 0.200 | 0.230 | 0.256 | 0.309 | 0.329 |
| | 6 | 0.173 | 0.229 | 0.260 | 0.288 | 0.341 | 0.362 |
| | 7 | 0.200 | 0.257 | 0.290 | 0.318 | 0.372 | 0.393 |
| | 8 | 0.226 | 0.285 | 0.319 | 0.347 | 0.403 | 0.423 |
| | 9 | 0.252 | 0.313 | 0.347 | 0.376 | 0.432 | 0.452 |
| | 10 | 0.278 | 0.341 | 0.376 | 0.405 | 0.461 | 0.481 |
| | 11 | 0.304 | 0.368 | 0.403 | 0.433 | 0.488 | 0.509 |
| | 12 | 0.330 | 0.396 | 0.431 | 0.460 | 0.516 | 0.536 |
| | 13 | 0.356 | 0.422 | 0.458 | 0.487 | 0.543 | 0.563 |
| | 14 | 0.382 | 0.449 | 0.485 | 0.514 | 0.569 | 0.589 |
| | 15 | 0.408 | 0.476 | 0.511 | 0.540 | 0.595 | 0.614 |
| | 16 | 0.434 | 0.502 | 0.537 | 0.566 | 0.620 | 0.639 |
| | 17 | 0.460 | 0.528 | 0.563 | 0.592 | 0.644 | 0.663 |
| | 18 | 0.486 | 0.554 | 0.589 | 0.617 | 0.669 | 0.687 |
| | 19 | 0.513 | 0.580 | 0.614 | 0.642 | 0.692 | 0.710 |
| | 20 | 0.539 | 0.605 | 0.639 | 0.667 | 0.716 | 0.733 |
| | 21 | 0.565 | 0.631 | 0.664 | 0.691 | 0.738 | 0.755 |
| | 22 | 0.591 | 0.656 | 0.689 | 0.715 | 0.761 | 0.776 |
| 39 | 0 | 0.017 | 0.040 | 0.057 | 0.073 | 0.111 | 0.127 |
| | 1 | 0.042 | 0.074 | 0.096 | 0.115 | 0.158 | 0.175 |
| | 2 | 0.067 | 0.106 | 0.130 | 0.152 | 0.198 | 0.216 |
| | 3 | 0.093 | 0.136 | 0.163 | 0.186 | 0.235 | 0.254 |
| | 4 | 0.118 | 0.166 | 0.194 | 0.219 | 0.269 | 0.289 |
| | 5 | 0.144 | 0.195 | 0.224 | 0.250 | 0.302 | 0.322 |
| | 6 | 0.169 | 0.223 | 0.254 | 0.281 | 0.334 | 0.354 |
| | 7 | 0.194 | 0.251 | 0.283 | 0.310 | 0.364 | 0.384 |
| | 8 | 0.220 | 0.278 | 0.311 | 0.339 | 0.394 | 0.414 |
| | 9 | 0.245 | 0.306 | 0.339 | 0.368 | 0.422 | 0.443 |
| | 10 | 0.271 | 0.333 | 0.367 | 0.396 | 0.450 | 0.471 |
| | 11 | 0.296 | 0.359 | 0.394 | 0.423 | 0.478 | 0.498 |
| | 12 | 0.322 | 0.386 | 0.421 | 0.450 | 0.505 | 0.525 |
| | 13 | 0.347 | 0.412 | 0.447 | 0.476 | 0.531 | 0.551 |
| | 14 | 0.372 | 0.438 | 0.473 | 0.503 | 0.557 | 0.576 |
| | 15 | 0.398 | 0.464 | 0.499 | 0.528 | 0.582 | 0.601 |
| | 16 | 0.423 | 0.490 | 0.525 | 0.554 | 0.607 | 0.626 |
| | 17 | 0.449 | 0.516 | 0.550 | 0.579 | 0.631 | 0.650 |
| | 18 | 0.474 | 0.541 | 0.576 | 0.604 | 0.655 | 0.673 |
| | 19 | 0.500 | 0.566 | 0.600 | 0.628 | 0.678 | 0.696 |
| | 20 | 0.525 | 0.591 | 0.625 | 0.652 | 0.701 | 0.719 |
| | 21 | 0.550 | 0.616 | 0.649 | 0.676 | 0.724 | 0.741 |
| | 22 | 0.576 | 0.641 | 0.673 | 0.699 | 0.746 | 0.762 |
| | 23 | 0.601 | 0.665 | 0.697 | 0.723 | 0.768 | 0.783 |

APPENDIX 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 40 | 0 | 0.017 | 0.039 | 0.055 | 0.072 | 0.108 | 0.124 |
| | 1 | 0.041 | 0.073 | 0.093 | 0.113 | 0.154 | 0.171 |
| | 2 | 0.066 | 0.103 | 0.127 | 0.149 | 0.194 | 0.211 |
| | 3 | 0.091 | 0.133 | 0.159 | 0.182 | 0.229 | 0.248 |
| | 4 | 0.115 | 0.162 | 0.189 | 0.214 | 0.263 | 0.282 |
| | 5 | 0.140 | 0.190 | 0.219 | 0.245 | 0.295 | 0.315 |
| | 6 | 0.165 | 0.218 | 0.248 | 0.274 | 0.326 | 0.346 |
| | 7 | 0.190 | 0.245 | 0.276 | 0.303 | 0.356 | 0.376 |
| | 8 | 0.214 | 0.272 | 0.304 | 0.332 | 0.385 | 0.405 |
| | 9 | 0.239 | 0.298 | 0.331 | 0.359 | 0.413 | 0.433 |
| | 10 | 0.264 | 0.325 | 0.358 | 0.387 | 0.441 | 0.461 |
| | 11 | 0.289 | 0.351 | 0.385 | 0.413 | 0.468 | 0.488 |
| | 12 | 0.314 | 0.377 | 0.411 | 0.440 | 0.494 | 0.514 |
| | 13 | 0.338 | 0.403 | 0.437 | 0.466 | 0.520 | 0.539 |
| | 14 | 0.363 | 0.428 | 0.463 | 0.491 | 0.545 | 0.565 |
| | 15 | 0.388 | 0.453 | 0.488 | 0.517 | 0.570 | 0.589 |
| | 16 | 0.413 | 0.479 | 0.513 | 0.542 | 0.594 | 0.613 |
| | 17 | 0.438 | 0.504 | 0.538 | 0.566 | 0.618 | 0.637 |
| | 18 | 0.462 | 0.528 | 0.563 | 0.591 | 0.642 | 0.660 |
| | 19 | 0.487 | 0.553 | 0.587 | 0.615 | 0.665 | 0.683 |
| | 20 | 0.512 | 0.578 | 0.611 | 0.638 | 0.688 | 0.705 |
| | 21 | 0.537 | 0.602 | 0.635 | 0.662 | 0.710 | 0.727 |
| | 22 | 0.561 | 0.626 | 0.659 | 0.685 | 0.732 | 0.748 |
| | 23 | 0.586 | 0.650 | 0.682 | 0.708 | 0.753 | 0.769 |
| | 24 | 0.611 | 0.674 | 0.705 | 0.730 | 0.774 | 0.789 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 41 | 0 | 0.016 | 0.038 | 0.054 | 0.070 | 0.106 | 0.121 |
| | 1 | 0.040 | 0.071 | 0.091 | 0.110 | 0.151 | 0.167 |
| | 2 | 0.064 | 0.101 | 0.124 | 0.145 | 0.189 | 0.207 |
| | 3 | 0.088 | 0.130 | 0.155 | 0.178 | 0.224 | 0.242 |
| | 4 | 0.113 | 0.158 | 0.185 | 0.209 | 0.257 | 0.276 |
| | 5 | 0.137 | 0.185 | 0.214 | 0.239 | 0.289 | 0.308 |
| | 6 | 0.161 | 0.213 | 0.242 | 0.268 | 0.319 | 0.338 |
| | 7 | 0.185 | 0.239 | 0.270 | 0.296 | 0.348 | 0.368 |
| | 8 | 0.209 | 0.265 | 0.297 | 0.324 | 0.377 | 0.396 |
| | 9 | 0.233 | 0.291 | 0.324 | 0.351 | 0.404 | 0.424 |
| | 10 | 0.258 | 0.317 | 0.350 | 0.378 | 0.431 | 0.451 |
| | 11 | 0.282 | 0.343 | 0.376 | 0.404 | 0.458 | 0.478 |
| | 12 | 0.306 | 0.368 | 0.402 | 0.430 | 0.484 | 0.503 |
| | 13 | 0.330 | 0.393 | 0.427 | 0.456 | 0.509 | 0.529 |
| | 14 | 0.354 | 0.418 | 0.452 | 0.481 | 0.534 | 0.553 |
| | 15 | 0.379 | 0.443 | 0.477 | 0.506 | 0.558 | 0.578 |
| | 16 | 0.403 | 0.468 | 0.502 | 0.530 | 0.582 | 0.601 |
| | 17 | 0.427 | 0.492 | 0.526 | 0.554 | 0.606 | 0.625 |
| | 18 | 0.451 | 0.516 | 0.550 | 0.578 | 0.629 | 0.647 |
| | 19 | 0.475 | 0.541 | 0.574 | 0.602 | 0.652 | 0.670 |
| | 20 | 0.500 | 0.565 | 0.598 | 0.625 | 0.674 | 0.692 |
| | 21 | 0.524 | 0.588 | 0.621 | 0.648 | 0.696 | 0.713 |
| | 22 | 0.548 | 0.612 | 0.645 | 0.671 | 0.718 | 0.734 |
| | 23 | 0.572 | 0.636 | 0.668 | 0.693 | 0.739 | 0.755 |
| | 24 | 0.596 | 0.659 | 0.690 | 0.715 | 0.760 | 0.775 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 42 | 0 | 0.016 | 0.037 | 0.053 | 0.068 | 0.103 | 0.118 |
| | 1 | 0.039 | 0.069 | 0.089 | 0.108 | 0.147 | 0.163 |
| | 2 | 0.063 | 0.099 | 0.121 | 0.142 | 0.185 | 0.202 |
| | 3 | 0.086 | 0.127 | 0.152 | 0.174 | 0.219 | 0.237 |
| | 4 | 0.110 | 0.154 | 0.181 | 0.204 | 0.252 | 0.270 |
| | 5 | 0.133 | 0.181 | 0.209 | 0.234 | 0.283 | 0.301 |
| | 6 | 0.157 | 0.208 | 0.237 | 0.262 | 0.312 | 0.331 |
| | 7 | 0.181 | 0.234 | 0.264 | 0.290 | 0.341 | 0.360 |
| | 8 | 0.204 | 0.259 | 0.290 | 0.317 | 0.369 | 0.388 |
| | 9 | 0.228 | 0.285 | 0.317 | 0.344 | 0.396 | 0.415 |
| | 10 | 0.252 | 0.310 | 0.342 | 0.370 | 0.422 | 0.442 |
| | 11 | 0.275 | 0.335 | 0.368 | 0.396 | 0.448 | 0.468 |
| | 12 | 0.299 | 0.360 | 0.393 | 0.421 | 0.474 | 0.493 |
| | 13 | 0.322 | 0.384 | 0.418 | 0.446 | 0.499 | 0.518 |
| | 14 | 0.346 | 0.409 | 0.443 | 0.471 | 0.523 | 0.542 |
| | 15 | 0.370 | 0.433 | 0.467 | 0.495 | 0.547 | 0.566 |
| | 16 | 0.393 | 0.457 | 0.491 | 0.519 | 0.571 | 0.590 |
| | 17 | 0.417 | 0.481 | 0.515 | 0.543 | 0.594 | 0.613 |
| | 18 | 0.440 | 0.505 | 0.539 | 0.566 | 0.617 | 0.635 |
| | 19 | 0.464 | 0.529 | 0.562 | 0.589 | 0.639 | 0.657 |
| | 20 | 0.488 | 0.552 | 0.585 | 0.612 | 0.661 | 0.679 |
| | 21 | 0.511 | 0.575 | 0.608 | 0.635 | 0.683 | 0.700 |
| | 22 | 0.535 | 0.599 | 0.631 | 0.657 | 0.704 | 0.721 |
| | 23 | 0.559 | 0.622 | 0.654 | 0.679 | 0.725 | 0.741 |
| | 24 | 0.582 | 0.645 | 0.676 | 0.701 | 0.746 | 0.761 |
| | 25 | 0.606 | 0.667 | 0.698 | 0.723 | 0.766 | 0.781 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 43 | 0 | 0.015 | 0.036 | 0.052 | 0.067 | 0.101 | 0.115 |
| | 1 | 0.038 | 0.068 | 0.087 | 0.105 | 0.144 | 0.160 |
| | 2 | 0.061 | 0.096 | 0.119 | 0.139 | 0.181 | 0.198 |
| | 3 | 0.084 | 0.124 | 0.148 | 0.170 | 0.215 | 0.232 |
| | 4 | 0.107 | 0.151 | 0.177 | 0.200 | 0.246 | 0.264 |
| | 5 | 0.130 | 0.177 | 0.205 | 0.229 | 0.277 | 0.295 |
| | 6 | 0.153 | 0.203 | 0.232 | 0.256 | 0.306 | 0.324 |
| | 7 | 0.176 | 0.228 | 0.258 | 0.284 | 0.334 | 0.353 |
| | 8 | 0.200 | 0.254 | 0.284 | 0.310 | 0.361 | 0.380 |
| | 9 | 0.223 | 0.279 | 0.310 | 0.336 | 0.388 | 0.407 |
| | 10 | 0.246 | 0.303 | 0.335 | 0.362 | 0.414 | 0.433 |
| | 11 | 0.269 | 0.328 | 0.360 | 0.387 | 0.439 | 0.459 |
| | 12 | 0.292 | 0.352 | 0.385 | 0.412 | 0.464 | 0.484 |
| | 13 | 0.315 | 0.376 | 0.409 | 0.437 | 0.489 | 0.508 |
| | 14 | 0.338 | 0.400 | 0.433 | 0.461 | 0.513 | 0.532 |
| | 15 | 0.361 | 0.424 | 0.457 | 0.485 | 0.537 | 0.555 |
| | 16 | 0.384 | 0.447 | 0.481 | 0.508 | 0.560 | 0.578 |
| | 17 | 0.407 | 0.471 | 0.504 | 0.532 | 0.583 | 0.601 |
| | 18 | 0.430 | 0.494 | 0.527 | 0.555 | 0.605 | 0.623 |
| | 19 | 0.453 | 0.517 | 0.550 | 0.577 | 0.627 | 0.645 |
| | 20 | 0.476 | 0.540 | 0.573 | 0.600 | 0.649 | 0.667 |
| | 21 | 0.500 | 0.563 | 0.596 | 0.622 | 0.671 | 0.688 |
| | 22 | 0.523 | 0.586 | 0.618 | 0.644 | 0.692 | 0.708 |
| | 23 | 0.546 | 0.608 | 0.640 | 0.666 | 0.712 | 0.728 |
| | 24 | 0.569 | 0.631 | 0.662 | 0.688 | 0.733 | 0.748 |
| | 25 | 0.592 | 0.653 | 0.684 | 0.709 | 0.753 | 0.768 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 44 | 0 | 0.015 | 0.035 | 0.050 | 0.065 | 0.099 | 0.113 |
| | 1 | 0.037 | 0.066 | 0.085 | 0.103 | 0.141 | 0.157 |
| | 2 | 0.060 | 0.094 | 0.116 | 0.136 | 0.177 | 0.194 |
| | 3 | 0.082 | 0.121 | 0.145 | 0.166 | 0.210 | 0.227 |
| | 4 | 0.105 | 0.148 | 0.173 | 0.196 | 0.241 | 0.259 |
| | 5 | 0.127 | 0.173 | 0.200 | 0.224 | 0.271 | 0.289 |
| | 6 | 0.150 | 0.199 | 0.227 | 0.251 | 0.299 | 0.318 |
| | 7 | 0.172 | 0.223 | 0.253 | 0.278 | 0.327 | 0.346 |
| | 8 | 0.195 | 0.248 | 0.278 | 0.304 | 0.354 | 0.373 |
| | 9 | 0.218 | 0.272 | 0.303 | 0.329 | 0.380 | 0.399 |
| | 10 | 0.240 | 0.297 | 0.328 | 0.354 | 0.406 | 0.425 |
| | 11 | 0.263 | 0.321 | 0.352 | 0.379 | 0.431 | 0.450 |
| | 12 | 0.285 | 0.344 | 0.376 | 0.404 | 0.455 | 0.474 |
| | 13 | 0.308 | 0.368 | 0.400 | 0.428 | 0.479 | 0.498 |
| | 14 | 0.330 | 0.391 | 0.424 | 0.451 | 0.503 | 0.522 |
| | 15 | 0.353 | 0.415 | 0.447 | 0.475 | 0.526 | 0.545 |
| | 16 | 0.375 | 0.438 | 0.471 | 0.498 | 0.549 | 0.568 |
| | 17 | 0.398 | 0.461 | 0.494 | 0.521 | 0.572 | 0.590 |
| | 18 | 0.421 | 0.483 | 0.516 | 0.544 | 0.594 | 0.612 |
| | 19 | 0.443 | 0.506 | 0.539 | 0.566 | 0.616 | 0.633 |
| | 20 | 0.466 | 0.529 | 0.561 | 0.588 | 0.637 | 0.655 |
| | 21 | 0.488 | 0.551 | 0.584 | 0.610 | 0.658 | 0.675 |
| | 22 | 0.511 | 0.573 | 0.606 | 0.632 | 0.679 | 0.696 |
| | 23 | 0.533 | 0.596 | 0.627 | 0.653 | 0.699 | 0.716 |
| | 24 | 0.556 | 0.618 | 0.649 | 0.674 | 0.720 | 0.735 |
| | 25 | 0.578 | 0.640 | 0.671 | 0.695 | 0.739 | 0.755 |
| | 26 | 0.601 | 0.661 | 0.692 | 0.716 | 0.759 | 0.774 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 45 | 0 | 0.015 | 0.035 | 0.049 | 0.064 | 0.097 | 0.111 |
| | 1 | 0.037 | 0.065 | 0.083 | 0.101 | 0.138 | 0.153 |
| | 2 | 0.058 | 0.092 | 0.113 | 0.133 | 0.173 | 0.190 |
| | 3 | 0.080 | 0.119 | 0.142 | 0.163 | 0.206 | 0.223 |
| | 4 | 0.103 | 0.144 | 0.169 | 0.191 | 0.236 | 0.254 |
| | 5 | 0.125 | 0.170 | 0.196 | 0.219 | 0.265 | 0.283 |
| | 6 | 0.147 | 0.194 | 0.222 | 0.246 | 0.293 | 0.312 |
| | 7 | 0.169 | 0.219 | 0.247 | 0.272 | 0.321 | 0.339 |
| | 8 | 0.191 | 0.243 | 0.272 | 0.297 | 0.347 | 0.366 |
| | 9 | 0.213 | 0.267 | 0.297 | 0.323 | 0.373 | 0.391 |
| | 10 | 0.235 | 0.290 | 0.321 | 0.347 | 0.398 | 0.417 |
| | 11 | 0.257 | 0.314 | 0.345 | 0.372 | 0.422 | 0.441 |
| | 12 | 0.279 | 0.337 | 0.369 | 0.395 | 0.446 | 0.465 |
| | 13 | 0.301 | 0.360 | 0.392 | 0.419 | 0.470 | 0.489 |
| | 14 | 0.323 | 0.383 | 0.415 | 0.442 | 0.493 | 0.512 |
| | 15 | 0.345 | 0.406 | 0.438 | 0.465 | 0.516 | 0.535 |
| | 16 | 0.367 | 0.428 | 0.461 | 0.488 | 0.539 | 0.557 |
| | 17 | 0.389 | 0.451 | 0.484 | 0.511 | 0.561 | 0.579 |
| | 18 | 0.411 | 0.473 | 0.506 | 0.533 | 0.583 | 0.601 |
| | 19 | 0.433 | 0.496 | 0.528 | 0.555 | 0.604 | 0.622 |
| | 20 | 0.455 | 0.518 | 0.550 | 0.577 | 0.626 | 0.643 |
| | 21 | 0.477 | 0.540 | 0.572 | 0.598 | 0.646 | 0.663 |
| | 22 | 0.500 | 0.562 | 0.594 | 0.620 | 0.667 | 0.684 |
| | 23 | 0.522 | 0.583 | 0.615 | 0.641 | 0.687 | 0.703 |
| | 24 | 0.544 | 0.605 | 0.636 | 0.662 | 0.707 | 0.723 |
| | 25 | 0.566 | 0.627 | 0.657 | 0.682 | 0.727 | 0.742 |
| | 26 | 0.588 | 0.648 | 0.678 | 0.703 | 0.746 | 0.761 |
| | 27 | 0.610 | 0.669 | 0.699 | 0.723 | 0.765 | 0.779 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 46 | 0 | 0.014 | 0.034 | 0.048 | 0.063 | 0.095 | 0.108 |
| | 1 | 0.036 | 0.063 | 0.081 | 0.099 | 0.135 | 0.150 |
| | 2 | 0.057 | 0.090 | 0.111 | 0.130 | 0.170 | 0.186 |
| | 3 | 0.079 | 0.116 | 0.139 | 0.160 | 0.202 | 0.218 |
| | 4 | 0.100 | 0.141 | 0.166 | 0.188 | 0.232 | 0.249 |
| | 5 | 0.122 | 0.166 | 0.192 | 0.215 | 0.260 | 0.278 |
| | 6 | 0.143 | 0.190 | 0.217 | 0.241 | 0.288 | 0.306 |
| | 7 | 0.165 | 0.214 | 0.242 | 0.266 | 0.314 | 0.332 |
| | 8 | 0.187 | 0.238 | 0.267 | 0.291 | 0.340 | 0.359 |
| | 9 | 0.208 | 0.261 | 0.291 | 0.316 | 0.365 | 0.384 |
| | 10 | 0.230 | 0.284 | 0.315 | 0.340 | 0.390 | 0.409 |
| | 11 | 0.251 | 0.307 | 0.338 | 0.364 | 0.414 | 0.433 |
| | 12 | 0.273 | 0.330 | 0.361 | 0.388 | 0.438 | 0.457 |
| | 13 | 0.294 | 0.353 | 0.384 | 0.411 | 0.461 | 0.480 |
| | 14 | 0.316 | 0.375 | 0.407 | 0.434 | 0.484 | 0.503 |
| | 15 | 0.338 | 0.397 | 0.430 | 0.456 | 0.507 | 0.525 |
| | 16 | 0.359 | 0.420 | 0.452 | 0.479 | 0.529 | 0.547 |
| | 17 | 0.381 | 0.442 | 0.474 | 0.501 | 0.551 | 0.569 |
| | 18 | 0.402 | 0.464 | 0.496 | 0.523 | 0.572 | 0.590 |
| | 19 | 0.424 | 0.486 | 0.518 | 0.544 | 0.594 | 0.611 |
| | 20 | 0.446 | 0.507 | 0.539 | 0.566 | 0.614 | 0.632 |
| | 21 | 0.467 | 0.529 | 0.561 | 0.587 | 0.635 | 0.652 |
| | 22 | 0.489 | 0.550 | 0.582 | 0.608 | 0.655 | 0.672 |
| | 23 | 0.510 | 0.572 | 0.603 | 0.629 | 0.675 | 0.692 |
| | 24 | 0.532 | 0.593 | 0.624 | 0.649 | 0.695 | 0.711 |
| | 25 | 0.553 | 0.614 | 0.645 | 0.670 | 0.714 | 0.730 |
| | 26 | 0.575 | 0.635 | 0.665 | 0.690 | 0.733 | 0.748 |
| | 27 | 0.597 | 0.656 | 0.686 | 0.710 | 0.752 | 0.767 |

## Appendix 3B

### Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 47 | 0 | 0.014 | 0.033 | 0.047 | 0.061 | 0.093 | 0.106 |
| | 1 | 0.035 | 0.062 | 0.080 | 0.097 | 0.133 | 0.147 |
| | 2 | 0.056 | 0.088 | 0.109 | 0.127 | 0.167 | 0.182 |
| | 3 | 0.077 | 0.114 | 0.136 | 0.156 | 0.198 | 0.214 |
| | 4 | 0.098 | 0.138 | 0.162 | 0.184 | 0.227 | 0.244 |
| | 5 | 0.119 | 0.163 | 0.188 | 0.210 | 0.255 | 0.272 |
| | 6 | 0.140 | 0.186 | 0.213 | 0.236 | 0.282 | 0.300 |
| | 7 | 0.162 | 0.210 | 0.237 | 0.261 | 0.308 | 0.326 |
| | 8 | 0.183 | 0.233 | 0.261 | 0.286 | 0.334 | 0.352 |
| | 9 | 0.204 | 0.256 | 0.285 | 0.310 | 0.358 | 0.377 |
| | 10 | 0.225 | 0.278 | 0.308 | 0.334 | 0.383 | 0.401 |
| | 11 | 0.246 | 0.301 | 0.331 | 0.357 | 0.407 | 0.425 |
| | 12 | 0.267 | 0.323 | 0.354 | 0.380 | 0.430 | 0.448 |
| | 13 | 0.288 | 0.345 | 0.377 | 0.403 | 0.453 | 0.471 |
| | 14 | 0.309 | 0.368 | 0.399 | 0.425 | 0.475 | 0.494 |
| | 15 | 0.331 | 0.389 | 0.421 | 0.448 | 0.498 | 0.516 |
| | 16 | 0.352 | 0.411 | 0.443 | 0.470 | 0.519 | 0.538 |
| | 17 | 0.373 | 0.433 | 0.465 | 0.491 | 0.541 | 0.559 |
| | 18 | 0.394 | 0.454 | 0.486 | 0.513 | 0.562 | 0.580 |
| | 19 | 0.415 | 0.476 | 0.508 | 0.534 | 0.583 | 0.601 |
| | 20 | 0.436 | 0.497 | 0.529 | 0.555 | 0.604 | 0.621 |
| | 21 | 0.457 | 0.518 | 0.550 | 0.576 | 0.624 | 0.641 |
| | 22 | 0.478 | 0.539 | 0.571 | 0.597 | 0.644 | 0.661 |
| | 23 | 0.500 | 0.560 | 0.592 | 0.617 | 0.664 | 0.680 |
| | 24 | 0.521 | 0.581 | 0.612 | 0.637 | 0.683 | 0.699 |
| | 25 | 0.542 | 0.602 | 0.633 | 0.657 | 0.702 | 0.718 |
| | 26 | 0.563 | 0.623 | 0.653 | 0.677 | 0.721 | 0.736 |
| | 27 | 0.584 | 0.643 | 0.673 | 0.697 | 0.740 | 0.754 |
| | 28 | 0.605 | 0.664 | 0.693 | 0.716 | 0.758 | 0.772 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 48 | 0 | 0.014 | 0.032 | 0.046 | 0.060 | 0.091 | 0.104 |
| | 1 | 0.034 | 0.061 | 0.078 | 0.095 | 0.130 | 0.144 |
| | 2 | 0.055 | 0.087 | 0.107 | 0.125 | 0.163 | 0.179 |
| | 3 | 0.075 | 0.111 | 0.133 | 0.153 | 0.194 | 0.210 |
| | 4 | 0.096 | 0.136 | 0.159 | 0.180 | 0.223 | 0.239 |
| | 5 | 0.117 | 0.159 | 0.184 | 0.206 | 0.250 | 0.267 |
| | 6 | 0.137 | 0.182 | 0.209 | 0.231 | 0.277 | 0.294 |
| | 7 | 0.158 | 0.205 | 0.233 | 0.256 | 0.302 | 0.320 |
| | 8 | 0.179 | 0.228 | 0.256 | 0.280 | 0.327 | 0.345 |
| | 9 | 0.200 | 0.251 | 0.279 | 0.304 | 0.352 | 0.370 |
| | 10 | 0.220 | 0.273 | 0.302 | 0.327 | 0.376 | 0.394 |
| | 11 | 0.241 | 0.295 | 0.325 | 0.350 | 0.399 | 0.417 |
| | 12 | 0.262 | 0.317 | 0.347 | 0.373 | 0.422 | 0.440 |
| | 13 | 0.282 | 0.339 | 0.369 | 0.395 | 0.445 | 0.463 |
| | 14 | 0.303 | 0.360 | 0.391 | 0.417 | 0.467 | 0.485 |
| | 15 | 0.324 | 0.382 | 0.413 | 0.439 | 0.489 | 0.507 |
| | 16 | 0.344 | 0.403 | 0.435 | 0.461 | 0.510 | 0.528 |
| | 17 | 0.365 | 0.424 | 0.456 | 0.482 | 0.531 | 0.549 |
| | 18 | 0.386 | 0.445 | 0.477 | 0.503 | 0.552 | 0.570 |
| | 19 | 0.406 | 0.466 | 0.498 | 0.524 | 0.573 | 0.590 |
| | 20 | 0.427 | 0.487 | 0.519 | 0.545 | 0.593 | 0.610 |
| | 21 | 0.448 | 0.508 | 0.540 | 0.566 | 0.613 | 0.630 |
| | 22 | 0.468 | 0.529 | 0.560 | 0.586 | 0.633 | 0.650 |
| | 23 | 0.489 | 0.549 | 0.581 | 0.606 | 0.652 | 0.669 |
| | 24 | 0.510 | 0.570 | 0.60[illegible] | 0.626 | 0.672 | 0.688 |
| | 25 | 0.531 | 0.590 | 0.621 | 0.646 | 0.690 | 0.706 |
| | 26 | 0.551 | 0.611 | 0.641 | 0.665 | 0.709 | 0.725 |
| | 27 | 0.572 | 0.631 | 0.661 | 0.685 | 0.727 | 0.742 |
| | 28 | 0.593 | 0.651 | 0.680 | 0.704 | 0.746 | 0.760 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 49 | 0 | 0.014 | 0.032 | 0.045 | 0.059 | 0.089 | 0.102 |
| | 1 | 0.034 | 0.059 | 0.077 | 0.093 | 0.127 | 0.142 |
| | 2 | 0.054 | 0.085 | 0.104 | 0.122 | 0.160 | 0.175 |
| | 3 | 0.074 | 0.109 | 0.131 | 0.150 | 0.190 | 0.206 |
| | 4 | 0.094 | 0.133 | 0.156 | 0.177 | 0.219 | 0.235 |
| | 5 | 0.114 | 0.156 | 0.181 | 0.202 | 0.246 | 0.262 |
| | 6 | 0.135 | 0.179 | 0.205 | 0.227 | 0.272 | 0.289 |
| | 7 | 0.155 | 0.201 | 0.228 | 0.251 | 0.297 | 0.314 |
| | 8 | 0.175 | 0.224 | 0.251 | 0.275 | 0.321 | 0.339 |
| | 9 | 0.195 | 0.246 | 0.274 | 0.298 | 0.345 | 0.363 |
| | 10 | 0.216 | 0.268 | 0.296 | 0.321 | 0.369 | 0.387 |
| | 11 | 0.236 | 0.289 | 0.319 | 0.344 | 0.392 | 0.410 |
| | 12 | 0.256 | 0.311 | 0.341 | 0.366 | 0.414 | 0.433 |
| | 13 | 0.277 | 0.332 | 0.362 | 0.388 | 0.437 | 0.455 |
| | 14 | 0.297 | 0.353 | 0.384 | 0.410 | 0.459 | 0.477 |
| | 15 | 0.317 | 0.374 | 0.405 | 0.431 | 0.480 | 0.498 |
| | 16 | 0.337 | 0.395 | 0.426 | 0.452 | 0.501 | 0.519 |
| | 17 | 0.358 | 0.416 | 0.447 | 0.473 | 0.522 | 0.540 |
| | 18 | 0.378 | 0.437 | 0.468 | 0.494 | 0.543 | 0.560 |
| | 19 | 0.398 | 0.457 | 0.489 | 0.515 | 0.563 | 0.580 |
| | 20 | 0.418 | 0.478 | 0.509 | 0.535 | 0.583 | 0.600 |
| | 21 | 0.439 | 0.498 | 0.530 | 0.555 | 0.603 | 0.620 |
| | 22 | 0.459 | 0.519 | 0.550 | 0.575 | 0.622 | 0.639 |
| | 23 | 0.479 | 0.539 | 0.570 | 0.595 | 0.641 | 0.658 |
| | 24 | 0.500 | 0.559 | 0.590 | 0.615 | 0.660 | 0.677 |
| | 25 | 0.520 | 0.579 | 0.610 | 0.634 | 0.679 | 0.695 |
| | 26 | 0.540 | 0.599 | 0.629 | 0.654 | 0.698 | 0.713 |
| | 27 | 0.560 | 0.619 | 0.649 | 0.673 | 0.716 | 0.731 |
| | 28 | 0.581 | 0.639 | 0.668 | 0.691 | 0.734 | 0.748 |
| | 29 | 0.601 | 0.658 | 0.687 | 0.710 | 0.751 | 0.766 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 50 | 0 | 0.013 | 0.031 | 0.045 | 0.058 | 0.087 | 0.100 |
| | 1 | 0.033 | 0.058 | 0.075 | 0.091 | 0.125 | 0.139 |
| | 2 | 0.053 | 0.083 | 0.102 | 0.120 | 0.157 | 0.172 |
| | 3 | 0.072 | 0.107 | 0.128 | 0.147 | 0.187 | 0.202 |
| | 4 | 0.092 | 0.130 | 0.153 | 0.173 | 0.215 | 0.231 |
| | 5 | 0.112 | 0.153 | 0.177 | 0.198 | 0.241 | 0.258 |
| | 6 | 0.132 | 0.175 | 0.201 | 0.223 | 0.267 | 0.284 |
| | 7 | 0.152 | 0.197 | 0.224 | 0.246 | 0.291 | 0.309 |
| | 8 | 0.172 | 0.219 | 0.246 | 0.270 | 0.316 | 0.333 |
| | 9 | 0.192 | 0.241 | 0.269 | 0.293 | 0.339 | 0.357 |
| | 10 | 0.211 | 0.262 | 0.291 | 0.315 | 0.362 | 0.380 |
| | 11 | 0.231 | 0.284 | 0.313 | 0.337 | 0.385 | 0.403 |
| | 12 | 0.251 | 0.305 | 0.334 | 0.359 | 0.407 | 0.425 |
| | 13 | 0.271 | 0.326 | 0.356 | 0.381 | 0.429 | 0.447 |
| | 14 | 0.291 | 0.346 | 0.377 | 0.402 | 0.451 | 0.468 |
| | 15 | 0.311 | 0.367 | 0.398 | 0.423 | 0.472 | 0.489 |
| | 16 | 0.331 | 0.388 | 0.418 | 0.444 | 0.493 | 0.510 |
| | 17 | 0.351 | 0.408 | 0.439 | 0.465 | 0.513 | 0.531 |
| | 18 | 0.370 | 0.429 | 0.460 | 0.485 | 0.533 | 0.551 |
| | 19 | 0.390 | 0.449 | 0.480 | 0.506 | 0.553 | 0.571 |
| | 20 | 0.410 | 0.469 | 0.500 | 0.526 | 0.573 | 0.590 |
| | 21 | 0.430 | 0.489 | 0.520 | 0.546 | 0.593 | 0.610 |
| | 22 | 0.450 | 0.509 | 0.540 | 0.565 | 0.612 | 0.629 |
| | 23 | 0.470 | 0.529 | 0.560 | 0.585 | 0.631 | 0.647 |
| | 24 | 0.490 | 0.549 | 0.579 | 0.604 | 0.650 | 0.666 |
| | 25 | 0.509 | 0.568 | 0.599 | 0.623 | 0.668 | 0.684 |
| | 26 | 0.529 | 0.588 | 0.618 | 0.642 | 0.686 | 0.702 |
| | 27 | 0.549 | 0.607 | 0.637 | 0.661 | 0.704 | 0.720 |
| | 28 | 0.569 | 0.627 | 0.656 | 0.680 | 0.722 | 0.737 |
| | 29 | 0.589 | 0.646 | 0.675 | 0.698 | 0.740 | 0.754 |
| | 30 | 0.609 | 0.665 | 0.694 | 0.716 | 0.757 | 0.771 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 55 | 0 | 0.012 | 0.028 | 0.041 | 0.053 | 0.080 | 0.091 |
| | 1 | 0.030 | 0.053 | 0.068 | 0.083 | 0.014 | 0.127 |
| | 2 | 0.048 | 0.076 | 0.093 | 0.110 | 0.144 | 0.157 |
| | 3 | 0.066 | 0.097 | 0.117 | 0.134 | 0.171 | 0.185 |
| | 4 | 0.084 | 0.119 | 0.140 | 0.158 | 0.196 | 0.211 |
| | 5 | 0.102 | 0.139 | 0.162 | 0.181 | 0.221 | 0.236 |
| | 6 | 0.120 | 0.160 | 0.183 | 0.204 | 0.244 | 0.260 |
| | 7 | 0.138 | 0.180 | 0.204 | 0.225 | 0.267 | 0.283 |
| | 8 | 0.156 | 0.200 | 0.225 | 0.247 | 0.289 | 0.306 |
| | 9 | 0.174 | 0.220 | 0.245 | 0.268 | 0.311 | 0.328 |
| | 10 | 0.192 | 0.239 | 0.266 | 0.288 | 0.333 | 0.349 |
| | 11 | 0.210 | 0.259 | 0.286 | 0.309 | 0.354 | 0.370 |
| | 12 | 0.228 | 0.278 | 0.306 | 0.329 | 0.374 | 0.391 |
| | 13 | 0.247 | 0.297 | 0.325 | 0.349 | 0.394 | 0.411 |
| | 14 | 0.265 | 0.316 | 0.345 | 0.368 | 0.414 | 0.431 |
| | 15 | 0.283 | 0.335 | 0.364 | 0.388 | 0.434 | 0.451 |
| | 16 | 0.301 | 0.354 | 0.383 | 0.407 | 0.453 | 0.470 |
| | 17 | 0.319 | 0.373 | 0.402 | 0.426 | 0.473 | 0.489 |
| | 18 | 0.337 | 0.391 | 0.421 | 0.445 | 0.491 | 0.508 |
| | 19 | 0.355 | 0.410 | 0.440 | 0.464 | 0.510 | 0.527 |
| | 20 | 0.373 | 0.429 | 0.458 | 0.483 | 0.529 | 0.545 |
| | 21 | 0.391 | 0.447 | 0.477 | 0.501 | 0.547 | 0.563 |
| | 22 | 0.409 | 0.465 | 0.495 | 0.519 | 0.565 | 0.581 |
| | 23 | 0.427 | 0.484 | 0.513 | 0.537 | 0.583 | 0.599 |
| | 24 | 0.445 | 0.502 | 0.531 | 0.555 | 0.600 | 0.616 |
| | 25 | 0.463 | 0.520 | 0.549 | 0.573 | 0.618 | 0.634 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 60 | 0 | 0.011 | 0.026 | 0.037 | 0.048 | 0.073 | 0.084 |
| | 1 | 0.027 | 0.049 | 0.063 | 0.076 | 0.105 | 0.117 |
| | 2 | 0.044 | 0.069 | 0.086 | 0.101 | 0.132 | 0.145 |
| | 3 | 0.060 | 0.090 | 0.107 | 0.124 | 0.157 | 0.171 |
| | 4 | 0.077 | 0.109 | 0.128 | 0.146 | 0.181 | 0.195 |
| | 5 | 0.093 | 0.128 | 0.149 | 0.167 | 0.204 | 0.218 |
| | 6 | 0.110 | 0.147 | 0.168 | 0.187 | 0.225 | 0.240 |
| | 7 | 0.127 | 0.165 | 0.188 | 0.207 | 0.247 | 0.262 |
| | 8 | 0.143 | 0.184 | 0.207 | 0.227 | 0.267 | 0.283 |
| | 9 | 0.160 | 0.202 | 0.226 | 0.247 | 0.287 | 0.303 |
| | 10 | 0.176 | 0.220 | 0.245 | 0.266 | 0.307 | 0.323 |
| | 11 | 0.193 | 0.238 | 0.263 | 0.285 | 0.327 | 0.343 |
| | 12 | 0.209 | 0.256 | 0.281 | 0.303 | 0.346 | 0.362 |
| | 13 | 0.226 | 0.273 | 0.299 | 0.322 | 0.365 | 0.381 |
| | 14 | 0.243 | 0.291 | 0.317 | 0.340 | 0.383 | 0.400 |
| | 15 | 0.259 | 0.308 | 0.335 | 0.358 | 0.402 | 0.418 |
| | 16 | 0.276 | 0.326 | 0.353 | 0.376 | 0.420 | 0.436 |
| | 17 | 0.292 | 0.343 | 0.371 | 0.394 | 0.438 | 0.454 |
| | 18 | 0.309 | 0.360 | 0.388 | 0.411 | 0.455 | 0.472 |
| | 19 | 0.325 | 0.377 | 0.405 | 0.429 | 0.473 | 0.489 |
| | 20 | 0.342 | 0.394 | 0.423 | 0.446 | 0.490 | 0.506 |
| | 21 | 0.359 | 0.411 | 0.440 | 0.463 | 0.507 | 0.523 |
| | 22 | 0.375 | 0.428 | 0.457 | 0.480 | 0.524 | 0.540 |
| | 23 | 0.392 | 0.445 | 0.474 | 0.497 | 0.541 | 0.557 |
| | 24 | 0.408 | 0.462 | 0.490 | 0.514 | 0.557 | 0.573 |
| | 25 | 0.425 | 0.479 | 0.507 | 0.531 | 0.574 | 0.590 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 65 | 0 | 0.010 | 0.024 | 0.034 | 0.045 | 0.068 | 0.078 |
| | 1 | 0.025 | 0.045 | 0.058 | 0.070 | 0.097 | 0.108 |
| | 2 | 0.040 | 0.064 | 0.079 | 0.093 | 0.123 | 0.134 |
| | 3 | 0.056 | 0.083 | 0.099 | 0.114 | 0.146 | 0.158 |
| | 4 | 0.071 | 0.101 | 0.119 | 0.135 | 0.168 | 0.181 |
| | 5 | 0.086 | 0.118 | 0.138 | 0.154 | 0.189 | 0.202 |
| | 6 | 0.102 | 0.136 | 0.156 | 0.174 | 0.209 | 0.223 |
| | 7 | 0.117 | 0.153 | 0.174 | 0.192 | 0.229 | 0.243 |
| | 8 | 0.132 | 0.170 | 0.192 | 0.211 | 0.248 | 0.263 |
| | 9 | 0.147 | 0.187 | 0.209 | 0.229 | 0.267 | 0.282 |
| | 10 | 0.163 | 0.204 | 0.227 | 0.246 | 0.286 | 0.300 |
| | 11 | 0.178 | 0.220 | 0.244 | 0.264 | 0.304 | 0.319 |
| | 12 | 0.193 | 0.237 | 0.261 | 0.281 | 0.322 | 0.337 |
| | 13 | 0.209 | 0.253 | 0.278 | 0.299 | 0.339 | 0.355 |
| | 14 | 0.224 | 0.269 | 0.294 | 0.316 | 0.357 | 0.372 |
| | 15 | 0.239 | 0.285 | 0.311 | 0.332 | 0.374 | 0.389 |
| | 16 | 0.255 | 0.302 | 0.327 | 0.349 | 0.391 | 0.406 |
| | 17 | 0.270 | 0.318 | 0.344 | 0.366 | 0.408 | 0.423 |
| | 18 | 0.285 | 0.334 | 0.360 | 0.382 | 0.424 | 0.440 |
| | 19 | 0.301 | 0.350 | 0.376 | 0.398 | 0.441 | 0.456 |
| | 20 | 0.316 | 0.365 | 0.392 | 0.414 | 0.457 | 0.472 |
| | 21 | 0.331 | 0.381 | 0.408 | 0.430 | 0.473 | 0.488 |
| | 22 | 0.346 | 0.397 | 0.424 | 0.446 | 0.489 | 0.504 |
| | 23 | 0.362 | 0.413 | 0.440 | 0.462 | 0.505 | 0.520 |
| | 24 | 0.377 | 0.428 | 0.455 | 0.478 | 0.520 | 0.536 |
| | 25 | 0.392 | 0.444 | 0.471 | 0.494 | 0.536 | 0.551 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 70 | 0 | 0.009 | 0.022 | 0.032 | 0.041 | 0.063 | 0.072 |
| | 1 | 0.023 | 0.042 | 0.054 | 0.065 | 0.091 | 0.101 |
| | 2 | 0.038 | 0.060 | 0.074 | 0.087 | 0.114 | 0.125 |
| | 3 | 0.052 | 0.077 | 0.092 | 0.107 | 0.136 | 0.148 |
| | 4 | 0.066 | 0.094 | 0.110 | 0.126 | 0.156 | 0.169 |
| | 5 | 0.080 | 0.110 | 0.128 | 0.144 | 0.176 | 0.189 |
| | 6 | 0.094 | 0.126 | 0.145 | 0.162 | 0.195 | 0.208 |
| | 7 | 0.109 | 0.142 | 0.162 | 0.179 | 0.214 | 0.227 |
| | 8 | 0.123 | 0.158 | 0.179 | 0.196 | 0.232 | 0.245 |
| | 9 | 0.137 | 0.174 | 0.195 | 0.213 | 0.249 | 0.263 |
| | 10 | 0.151 | 0.189 | 0.211 | 0.230 | 0.267 | 0.281 |
| | 11 | 0.165 | 0.205 | 0.227 | 0.246 | 0.284 | 0.298 |
| | 12 | 0.180 | 0.220 | 0.243 | 0.262 | 0.301 | 0.315 |
| | 13 | 0.194 | 0.235 | 0.259 | 0.278 | 0.317 | 0.332 |
| | 14 | 0.208 | 0.251 | 0.274 | 0.294 | 0.333 | 0.348 |
| | 15 | 0.222 | 0.266 | 0.290 | 0.310 | 0.350 | 0.364 |
| | 16 | 0.236 | 0.281 | 0.305 | 0.326 | 0.366 | 0.380 |
| | 17 | 0.251 | 0.296 | 0.320 | 0.341 | 0.381 | 0.396 |
| | 18 | 0.265 | 0.311 | 0.336 | 0.357 | 0.397 | 0.412 |
| | 19 | 0.279 | 0.325 | 0.351 | 0.372 | 0.412 | 0.427 |
| | 20 | 0.293 | 0.340 | 0.366 | 0.387 | 0.428 | 0.443 |
| | 21 | 0.308 | 0.355 | 0.381 | 0.402 | 0.443 | 0.458 |
| | 22 | 0.322 | 0.370 | 0.395 | 0.417 | 0.458 | 0.473 |
| | 23 | 0.336 | 0.384 | 0.410 | 0.432 | 0.473 | 0.488 |
| | 24 | 0.350 | 0.399 | 0.425 | 0.447 | 0.487 | 0.502 |
| | 25 | 0.364 | 0.413 | 0.440 | 0.461 | 0.502 | 0.517 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 75 | 0 | 0.009 | 0.021 | 0.030 | 0.039 | 0.059 | 0.068 |
| | 1 | 0.022 | 0.039 | 0.050 | 0.061 | 0.085 | 0.094 |
| | 2 | 0.035 | 0.056 | 0.069 | 0.081 | 0.107 | 0.117 |
| | 3 | 0.048 | 0.072 | 0.086 | 0.100 | 0.127 | 0.138 |
| | 4 | 0.062 | 0.087 | 0.103 | 0.117 | 0.147 | 0.158 |
| | 5 | 0.075 | 0.103 | 0.120 | 0.135 | 0.165 | 0.177 |
| | 6 | 0.088 | 0.118 | 0.136 | 0.151 | 0.183 | 0.195 |
| | 7 | 0.101 | 0.133 | 0.151 | 0.168 | 0.200 | 0.213 |
| | 8 | 0.115 | 0.148 | 0.167 | 0.184 | 0.217 | 0.230 |
| | 9 | 0.128 | 0.162 | 0.182 | 0.200 | 0.234 | 0.247 |
| | 10 | 0.141 | 0.177 | 0.197 | 0.215 | 0.250 | 0.264 |
| | 11 | 0.154 | 0.191 | 0.212 | 0.231 | 0.266 | 0.280 |
| | 12 | 0.168 | 0.206 | 0.227 | 0.246 | 0.282 | 0.296 |
| | 13 | 0.181 | 0.220 | 0.242 | 0.261 | 0.298 | 0.312 |
| | 14 | 0.194 | 0.234 | 0.257 | 0.276 | 0.313 | 0.327 |
| | 15 | 0.207 | 0.249 | 0.271 | 0.291 | 0.328 | 0.342 |
| | 16 | 0.221 | 0.263 | 0.286 | 0.305 | 0.343 | 0.358 |
| | 17 | 0.234 | 0.277 | 0.300 | 0.320 | 0.358 | 0.372 |
| | 18 | 0.247 | 0.291 | 0.314 | 0.334 | 0.373 | 0.387 |
| | 19 | 0.261 | 0.305 | 0.328 | 0.349 | 0.387 | 0.402 |
| | 20 | 0.274 | 0.318 | 0.343 | 0.363 | 0.402 | 0.416 |
| | 21 | 0.287 | 0.332 | 0.357 | 0.377 | 0.416 | 0.431 |
| | 22 | 0.300 | 0.346 | 0.371 | 0.391 | 0.430 | 0.445 |
| | 23 | 0.314 | 0.360 | 0.384 | 0.405 | 0.445 | 0.459 |
| | 24 | 0.327 | 0.373 | 0.398 | 0.419 | 0.459 | 0.473 |
| | 25 | 0.340 | 0.387 | 0.412 | 0.433 | 0.472 | 0.487 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 80 | 0 | 0.008 | 0.019 | 0.028 | 0.036 | 0.055 | 0.064 |
| | 1 | 0.020 | 0.036 | 0.047 | 0.057 | 0.080 | 0.089 |
| | 2 | 0.033 | 0.052 | 0.065 | 0.076 | 0.100 | 0.110 |
| | 3 | 0.045 | 0.067 | 0.081 | 0.094 | 0.120 | 0.130 |
| | 4 | 0.058 | 0.082 | 0.097 | 0.110 | 0.138 | 0.149 |
| | 5 | 0.070 | 0.097 | 0.112 | 0.126 | 0.155 | 0.166 |
| | 6 | 0.083 | 0.111 | 0.127 | 0.142 | 0.172 | 0.184 |
| | 7 | 0.095 | 0.125 | 0.142 | 0.158 | 0.188 | 0.200 |
| | 8 | 0.107 | 0.139 | 0.157 | 0.173 | 0.204 | 0.217 |
| | 9 | 0.120 | 0.153 | 0.171 | 0.188 | 0.220 | 0.233 |
| | 10 | 0.132 | 0.166 | 0.186 | 0.202 | 0.236 | 0.248 |
| | 11 | 0.145 | 0.180 | 0.200 | 0.217 | 0.251 | 0.264 |
| | 12 | 0.157 | 0.193 | 0.214 | 0.231 | 0.266 | 0.279 |
| | 13 | 0.170 | 0.207 | 0.228 | 0.245 | 0.280 | 0.294 |
| | 14 | 0.182 | 0.220 | 0.241 | 0.259 | 0.295 | 0.308 |
| | 15 | 0.195 | 0.233 | 0.255 | 0.273 | 0.309 | 0.323 |
| | 16 | 0.207 | 0.247 | 0.269 | 0.287 | 0.324 | 0.337 |
| | 17 | 0.219 | 0.260 | 0.282 | 0.301 | 0.338 | 0.351 |
| | 18 | 0.232 | 0.273 | 0.296 | 0.315 | 0.352 | 0.365 |
| | 19 | 0.244 | 0.286 | 0.309 | 0.328 | 0.365 | 0.379 |
| | 20 | 0.257 | 0.299 | 0.322 | 0.342 | 0.379 | 0.393 |
| | 21 | 0.269 | 0.312 | 0.335 | 0.355 | 0.393 | 0.407 |
| | 22 | 0.282 | 0.325 | 0.349 | 0.368 | 0.406 | 0.420 |
| | 23 | 0.294 | 0.338 | 0.362 | 0.382 | 0.420 | 0.434 |
| | 24 | 0.307 | 0.351 | 0.375 | 0.395 | 0.433 | 0.447 |
| | 25 | 0.319 | 0.364 | 0.388 | 0.408 | 0.446 | 0.460 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 85 | 0 | 0.008 | 0.018 | 0.026 | 0.034 | 0.052 | 0.060 |
| | 1 | 0.019 | 0.034 | 0.044 | 0.054 | 0.075 | 0.084 |
| | 2 | 0.031 | 0.049 | 0.061 | 0.072 | 0.095 | 0.104 |
| | 3 | 0.043 | 0.063 | 0.076 | 0.088 | 0.113 | 0.123 |
| | 4 | 0.054 | 0.077 | 0.091 | 0.104 | 0.130 | 0.140 |
| | 5 | 0.066 | 0.091 | 0.106 | 0.119 | 0.146 | 0.157 |
| | 6 | 0.078 | 0.104 | 0.120 | 0.134 | 0.162 | 0.173 |
| | 7 | 0.089 | 0.118 | 0.134 | 0.149 | 0.178 | 0.189 |
| | 8 | 0.101 | 0.131 | 0.148 | 0.163 | 0.193 | 0.205 |
| | 9 | 0.113 | 0.144 | 0.161 | 0.177 | 0.208 | 0.220 |
| | 10 | 0.125 | 0.157 | 0.175 | 0.191 | 0.223 | 0.235 |
| | 11 | 0.136 | 0.169 | 0.188 | 0.205 | 0.237 | 0.249 |
| | 12 | 0.148 | 0.182 | 0.202 | 0.218 | 0.251 | 0.264 |
| | 13 | 0.160 | 0.195 | 0.215 | 0.232 | 0.265 | 0.278 |
| | 14 | 0.171 | 0.207 | 0.228 | 0.245 | 0.279 | 0.292 |
| | 15 | 0.183 | 0.220 | 0.241 | 0.258 | 0.292 | 0.305 |
| | 16 | 0.195 | 0.233 | 0.253 | 0.271 | 0.306 | 0.319 |
| | 17 | 0.207 | 0.245 | 0.266 | 0.284 | 0.319 | 0.332 |
| | 18 | 0.218 | 0.257 | 0.279 | 0.297 | 0.333 | 0.346 |
| | 19 | 0.230 | 0.270 | 0.292 | 0.310 | 0.346 | 0.359 |
| | 20 | 0.242 | 0.282 | 0.304 | 0.323 | 0.359 | 0.372 |
| | 21 | 0.253 | 0.294 | 0.317 | 0.335 | 0.372 | 0.385 |
| | 22 | 0.265 | 0.307 | 0.329 | 0.348 | 0.384 | 0.398 |
| | 23 | 0.277 | 0.319 | 0.341 | 0.361 | 0.397 | 0.411 |
| | 24 | 0.289 | 0.331 | 0.354 | 0.373 | 0.410 | 0.423 |
| | 25 | 0.300 | 0.343 | 0.366 | 0.385 | 0.422 | 0.436 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 90 | 0 | 0.007 | 0.017 | 0.025 | 0.032 | 0.049 | 0.057 |
| | 1 | 0.018 | 0.032 | 0.042 | 0.051 | 0.071 | 0.079 |
| | 2 | 0.029 | 0.046 | 0.058 | 0.068 | 0.090 | 0.098 |
| | 3 | 0.040 | 0.060 | 0.072 | 0.083 | 0.107 | 0.116 |
| | 4 | 0.051 | 0.073 | 0.086 | 0.098 | 0.123 | 0.133 |
| | 5 | 0.062 | 0.086 | 0.100 | 0.113 | 0.139 | 0.149 |
| | 6 | 0.073 | 0.099 | 0.114 | 0.127 | 0.154 | 0.164 |
| | 7 | 0.084 | 0.111 | 0.127 | 0.141 | 0.169 | 0.179 |
| | 8 | 0.095 | 0.124 | 0.140 | 0.154 | 0.183 | 0.194 |
| | 9 | 0.107 | 0.136 | 0.153 | 0.168 | 0.197 | 0.208 |
| | 10 | 0.118 | 0.148 | 0.166 | 0.181 | 0.211 | 0.222 |
| | 11 | 0.129 | 0.160 | 0.178 | 0.194 | 0.224 | 0.236 |
| | 12 | 0.140 | 0.172 | 0.191 | 0.207 | 0.238 | 0.250 |
| | 13 | 0.151 | 0.184 | 0.203 | 0.219 | 0.251 | 0.263 |
| | 14 | 0.162 | 0.196 | 0.215 | 0.232 | 0.264 | 0.277 |
| | 15 | 0.173 | 0.208 | 0.228 | 0.244 | 0.277 | 0.290 |
| | 16 | 0.184 | 0.220 | 0.240 | 0.257 | 0.290 | 0.303 |
| | 17 | 0.195 | 0.232 | 0.252 | 0.269 | 0.303 | 0.316 |
| | 18 | 0.206 | 0.243 | 0.264 | 0.282 | 0.315 | 0.328 |
| | 19 | 0.217 | 0.255 | 0.276 | 0.294 | 0.328 | 0.341 |
| | 20 | 0.228 | 0.267 | 0.288 | 0.306 | 0.340 | 0.353 |
| | 21 | 0.239 | 0.278 | 0.300 | 0.318 | 0.353 | 0.366 |
| | 22 | 0.250 | 0.290 | 0.312 | 0.330 | 0.365 | 0.378 |
| | 23 | 0.262 | 0.302 | 0.323 | 0.342 | 0.377 | 0.390 |
| | 24 | 0.273 | 0.313 | 0.335 | 0.354 | 0.389 | 0.402 |
| | 25 | 0.284 | 0.325 | 0.347 | 0.365 | 0.401 | 0.414 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 95 | 0 | 0.007 | 0.016 | 0.023 | 0.031 | 0.047 | 0.054 |
| | 1 | 0.017 | 0.031 | 0.040 | 0.048 | 0.067 | 0.075 |
| | 2 | 0.028 | 0.044 | 0.055 | 0.064 | 0.085 | 0.093 |
| | 3 | 0.038 | 0.057 | 0.068 | 0.079 | 0.101 | 0.110 |
| | 4 | 0.048 | 0.069 | 0.082 | 0.093 | 0.117 | 0.126 |
| | 5 | 0.059 | 0.081 | 0.095 | 0.107 | 0.132 | 0.141 |
| | 6 | 0.069 | 0.093 | 0.108 | 0.120 | 0.146 | 0.156 |
| | 7 | 0.080 | 0.105 | 0.120 | 0.133 | 0.160 | 0.170 |
| | 8 | 0.090 | 0.117 | 0.133 | 0.146 | 0.174 | 0.184 |
| | 9 | 0.101 | 0.129 | 0.145 | 0.159 | 0.187 | 0.198 |
| | 10 | 0.111 | 0.140 | 0.157 | 0.172 | 0.200 | 0.211 |
| | 11 | 0.122 | 0.152 | 0.169 | 0.184 | 0.213 | 0.225 |
| | 12 | 0.132 | 0.163 | 0.181 | 0.196 | 0.226 | 0.238 |
| | 13 | 0.143 | 0.175 | 0.193 | 0.208 | 0.239 | 0.250 |
| | 14 | 0.153 | 0.186 | 0.204 | 0.220 | 0.251 | 0.263 |
| | 15 | 0.164 | 0.197 | 0.216 | 0.232 | 0.264 | 0.276 |
| | 16 | 0.174 | 0.209 | 0.228 | 0.244 | 0.276 | 0.288 |
| | 17 | 0.185 | 0.220 | 0.239 | 0.256 | 0.288 | 0.300 |
| | 18 | 0.195 | 0.231 | 0.251 | 0.267 | 0.300 | 0.312 |
| | 19 | 0.206 | 0.242 | 0.262 | 0.279 | 0.312 | 0.324 |
| | 20 | 0.216 | 0.253 | 0.273 | 0.391 | 0.324 | 0.336 |
| | 21 | 0.227 | 0.264 | 0.285 | 0.302 | 0.335 | 0.348 |
| | 22 | 0.237 | 0.275 | 0.296 | 0.313 | 0.347 | 0.360 |
| | 23 | 0.248 | 0.286 | 0.307 | 0.325 | 0.359 | 0.371 |
| | 24 | 0.258 | 0.297 | 0.318 | 0.336 | 0.370 | 0.383 |
| | 25 | 0.269 | 0.308 | 0.329 | 0.347 | 0.382 | 0.394 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 100 | 0 | 0.006 | 0.015 | 0.022 | 0.029 | 0.045 | 0.051 |
| | 1 | 0.016 | 0.029 | 0.038 | 0.046 | 0.064 | 0.071 |
| | 2 | 0.026 | 0.042 | 0.052 | 0.061 | 0.081 | 0.089 |
| | 3 | 0.036 | 0.054 | 0.065 | 0.075 | 0.096 | 0.105 |
| | 4 | 0.046 | 0.066 | 0.078 | 0.089 | 0.111 | 0.120 |
| | 5 | 0.056 | 0.077 | 0.090 | 0.102 | 0.125 | 0.135 |
| | 6 | 0.066 | 0.089 | 0.102 | 0.114 | 0.139 | 0.149 |
| | 7 | 0.076 | 0.100 | 0.114 | 0.127 | 0.152 | 0.162 |
| | 8 | 0.086 | 0.111 | 0.126 | 0.139 | 0.165 | 0.176 |
| | 9 | 0.096 | 0.122 | 0.138 | 0.151 | 0.178 | 0.189 |
| | 10 | 0.106 | 0.133 | 0.149 | 0.163 | 0.191 | 0.201 |
| | 11 | 0.116 | 0.144 | 0.161 | 0.175 | 0.203 | 0.214 |
| | 12 | 0.126 | 0.155 | 0.172 | 0.187 | 0.215 | 0.226 |
| | 13 | 0.136 | 0.166 | 0.183 | 0.198 | 0.228 | 0.239 |
| | 14 | 0.146 | 0.177 | 0.195 | 0.210 | 0.239 | 0.251 |
| | 15 | 0.156 | 0.188 | 0.206 | 0.221 | 0.251 | 0.263 |
| | 16 | 0.166 | 0.198 | 0.217 | 0.232 | 0.263 | 0.275 |
| | 17 | 0.176 | 0.209 | 0.228 | 0.244 | 0.275 | 0.286 |
| | 18 | 0.186 | 0.220 | 0.239 | 0.255 | 0.286 | 0.298 |
| | 19 | 0.196 | 0.230 | 0.249 | 0.266 | 0.297 | 0.309 |
| | 20 | 0.205 | 0.241 | 0.260 | 0.277 | 0.309 | 0.321 |
| | 21 | 0.215 | 0.251 | 0.271 | 0.288 | 0.320 | 0.332 |
| | 22 | 0.225 | 0.262 | 0.282 | 0.299 | 0.331 | 0.343 |
| | 23 | 0.235 | 0.272 | 0.292 | 0.309 | 0.342 | 0.354 |
| | 24 | 0.245 | 0.283 | 0.303 | 0.320 | 0.353 | 0.365 |
| | 25 | 0.255 | 0.293 | 0.314 | 0.331 | 0.364 | 0.376 |
| | 26 | 0.265 | 0.303 | 0.324 | 0.341 | 0.375 | 0.387 |
| | 27 | 0.275 | 0.314 | 0.335 | 0.352 | 0.386 | 0.398 |
| | 28 | 0.285 | 0.324 | 0.345 | 0.363 | 0.396 | 0.409 |
| | 29 | 0.295 | 0.334 | 0.356 | 0.373 | 0.407 | 0.420 |
| | 30 | 0.305 | 0.345 | 0.366 | 0.384 | 0.418 | 0.430 |
| | 31 | 0.315 | 0.355 | 0.376 | 0.394 | 0.428 | 0.441 |
| | 32 | 0.325 | 0.365 | 0.387 | 0.405 | 0.439 | 0.451 |
| | 33 | 0.335 | 0.375 | 0.397 | 0.415 | 0.449 | 0.462 |
| | 34 | 0.345 | 0.386 | 0.407 | 0.425 | 0.459 | 0.472 |
| | 35 | 0.355 | 0.396 | 0.418 | 0.436 | 0.470 | 0.482 |
| | 36 | 0.365 | 0.406 | 0.428 | 0.446 | 0.480 | 0.493 |
| | 37 | 0.375 | 0.416 | 0.438 | 0.456 | 0.490 | 0.503 |
| | 38 | 0.385 | 0.426 | 0.448 | 0.466 | 0.500 | 0.513 |
| | 39 | 0.395 | 0.436 | 0.458 | 0.476 | 0.511 | 0.523 |
| | 40 | 0.405 | 0.446 | 0.468 | 0.487 | 0.521 | 0.533 |
| | 41 | 0.415 | 0.456 | 0.478 | 0.497 | 0.531 | 0.543 |
| | 42 | 0.425 | 0.467 | 0.489 | 0.507 | 0.541 | 0.553 |
| | 43 | 0.435 | 0.477 | 0.499 | 0.517 | 0.551 | 0.563 |
| | 44 | 0.445 | 0.487 | 0.509 | 0.527 | 0.560 | 0.573 |
| | 45 | 0.455 | 0.497 | 0.519 | 0.537 | 0.570 | 0.582 |
| | 46 | 0.465 | 0.507 | 0.529 | 0.547 | 0.580 | 0.592 |
| | 47 | 0.475 | 0.517 | 0.538 | 0.556 | 0.590 | 0.602 |
| | 48 | 0.485 | 0.527 | 0.548 | 0.566 | 0.600 | 0.612 |
| | 49 | 0.495 | 0.536 | 0.558 | 0.576 | 0.609 | 0.621 |
| | 50 | 0.504 | 0.546 | 0.568 | 0.586 | 0.619 | 0.631 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 110 | 0 | 0.006 | 0.014 | 0.020 | 0.026 | 0.041 | 0.047 |
| | 1 | 0.015 | 0.026 | 0.034 | 0.042 | 0.058 | 0.065 |
| | 2 | 0.024 | 0.038 | 0.047 | 0.056 | 0.074 | 0.081 |
| | 3 | 0.033 | 0.049 | 0.059 | 0.068 | 0.088 | 0.096 |
| | 4 | 0.042 | 0.060 | 0.071 | 0.081 | 0.101 | 0.110 |
| | 5 | 0.051 | 0.070 | 0.082 | 0.093 | 0.114 | 0.123 |
| | 6 | 0.060 | 0.081 | 0.093 | 0.104 | 0.127 | 0.136 |
| | 7 | 0.069 | 0.091 | 0.104 | 0.116 | 0.139 | 0.148 |
| | 8 | 0.078 | 0.101 | 0.115 | 0.127 | 0.151 | 0.160 |
| | 9 | 0.087 | 0.111 | 0.126 | 0.138 | 0.163 | 0.172 |
| | 10 | 0.096 | 0.122 | 0.136 | 0.149 | 0.174 | 0.184 |
| | 11 | 0.105 | 0.132 | 0.147 | 0.160 | 0.186 | 0.196 |
| | 12 | 0.114 | 0.141 | 0.157 | 0.170 | 0.197 | 0.207 |
| | 13 | 0.123 | 0.151 | 0.167 | 0.181 | 0.208 | 0.218 |
| | 14 | 0.132 | 0.161 | 0.177 | 0.191 | 0.219 | 0.229 |
| | 15 | 0.142 | 0.171 | 0.187 | 0.202 | 0.230 | 0.240 |
| | 16 | 0.151 | 0.181 | 0.198 | 0.212 | 0.240 | 0.251 |
| | 17 | 0.160 | 0.190 | 0.208 | 0.222 | 0.251 | 0.262 |
| | 18 | 0.169 | 0.200 | 0.218 | 0.232 | 0.262 | 0.273 |
| | 19 | 0.178 | 0.210 | 0.227 | 0.243 | 0.272 | 0.283 |
| | 20 | 0.187 | 0.219 | 0.237 | 0.253 | 0.282 | 0.294 |
| | 21 | 0.196 | 0.229 | 0.247 | 0.263 | 0.293 | 0.304 |
| | 22 | 0.205 | 0.238 | 0.257 | 0.273 | 0.303 | 0.314 |
| | 23 | 0.214 | 0.248 | 0.267 | 0.283 | 0.313 | 0.325 |
| | 24 | 0.223 | 0.258 | 0.276 | 0.292 | 0.323 | 0.335 |
| | 25 | 0.232 | 0.267 | 0.286 | 0.302 | 0.333 | 0.345 |
| | 26 | 0.241 | 0.277 | 0.296 | 0.312 | 0.343 | 0.355 |
| | 27 | 0.250 | 0.286 | 0.305 | 0.322 | 0.353 | 0.365 |
| | 28 | 0.259 | 0.295 | 0.315 | 0.331 | 0.363 | 0.375 |
| | 29 | 0.268 | 0.305 | 0.325 | 0.341 | 0.373 | 0.385 |
| | 30 | 0.277 | 0.314 | 0.334 | 0.351 | 0.383 | 0.394 |
| | 31 | 0.287 | 0.324 | 0.344 | 0.360 | 0.392 | 0.404 |
| | 32 | 0.296 | 0.333 | 0.353 | 0.370 | 0.402 | 0.414 |
| | 33 | 0.305 | 0.342 | 0.363 | 0.379 | 0.412 | 0.424 |
| | 34 | 0.314 | 0.352 | 0.372 | 0.389 | 0.421 | 0.433 |
| | 35 | 0.323 | 0.361 | 0.381 | 0.398 | 0.431 | 0.443 |
| | 36 | 0.332 | 0.370 | 0.391 | 0.408 | 0.440 | 0.452 |
| | 37 | 0.341 | 0.379 | 0.400 | 0.417 | 0.450 | 0.462 |
| | 38 | 0.350 | 0.389 | 0.409 | 0.427 | 0.459 | 0.471 |
| | 39 | 0.359 | 0.398 | 0.419 | 0.436 | 0.468 | 0.480 |
| | 40 | 0.368 | 0.407 | 0.428 | 0.445 | 0.478 | 0.490 |
| | 41 | 0.377 | 0.416 | 9,437 | 0.455 | 0.487 | 0.499 |
| | 42 | 0.386 | 0.426 | 0.446 | 0.464 | 0.496 | 0.508 |
| | 43 | 0.395 | 0.435 | 0.456 | 0.473 | 0.506 | 0.517 |
| | 44 | 0.404 | 0.444 | 0.465 | 0.482 | 0.515 | 0.527 |
| | 45 | 0.413 | 0.453 | 0.474 | 0.491 | 0.524 | 0.536 |
| | 46 | 0.422 | 0.462 | 0.483 | 0.501 | 0.533 | 0.545 |
| | 47 | 0.432 | 0.471 | 0.492 | 0.510 | 0.542 | 0.554 |
| | 48 | 0.441 | 0.481 | 0.501 | 0.519 | 0.551 | 0.563 |
| | 49 | 0.450 | 0.490 | 0.511 | 0.528 | 0.560 | 0.572 |
| | 50 | 0.459 | 0.499 | 0.520 | 0.537 | 0.569 | 0.581 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 120 | 0 | 0.005 | 0.013 | 0.019 | 0.024 | 0.037 | 0.043 |
| | 1 | 0.013 | 0.024 | 0.032 | 0.038 | 0.054 | 0.060 |
| | 2 | 0.022 | 0.035 | 0.043 | 0.051 | 0.068 | 0.074 |
| | 3 | 0.030 | 0.045 | 0.054 | 0.063 | 0.081 | 0.088 |
| | 4 | 0.038 | 0.055 | 0.065 | 0.074 | 0.093 | 0.101 |
| | 5 | 0.047 | 0.065 | 0.075 | 0.085 | 0.105 | 0.113 |
| | 6 | 0.055 | 0.074 | 0.086 | 0.096 | 0.117 | 0.125 |
| | 7 | 0.063 | 0.084 | 0.096 | 0.106 | 0.128 | 0.136 |
| | 8 | 0.072 | 0.093 | 0.106 | 0.117 | 0.139 | 0.148 |
| | 9 | 0.080 | 0.102 | 0.115 | 0.127 | 0.150 | 0.159 |
| | 10 | 0.088 | 0.112 | 0.125 | 0.137 | 0.160 | 0.169 |
| | 11 | 0.096 | 0.121 | 0.135 | 0.147 | 0.171 | 0.180 |
| | 12 | 0.105 | 0.130 | 0.144 | 0.156 | 0.181 | 0.191 |
| | 13 | 0.113 | 0.139 | 0.154 | 0.166 | 0.191 | 0.201 |
| | 14 | 0.121 | 0.148 | 0.163 | 0.176 | 0.201 | 0.211 |
| | 15 | 0.130 | 0.157 | 0.172 | 0.185 | 0.211 | 0.221 |
| | 16 | 0.138 | 0.166 | 0.182 | 0.195 | 0.221 | 0.231 |
| | 17 | 0.146 | 0.175 | 0.191 | 0.204 | 0.231 | 0.241 |
| | 18 | 0.155 | 0.184 | 0.200 | 0.214 | 0.241 | 0.251 |
| | 19 | 0.163 | 0.193 | 0.209 | 0.223 | 0.251 | 0.261 |
| | 20 | 0.171 | 0.201 | 0.218 | 0.232 | 0.260 | 0.271 |
| | 21 | 0.180 | 0.210 | 0.227 | 0.242 | 0.270 | 0.280 |
| | 22 | 0.188 | 0.219 | 0.236 | 0.251 | 0.279 | 0.290 |
| | 23 | 0.196 | 0.228 | 0.245 | 0.260 | 0.289 | 0.299 |
| | 24 | 0.204 | 0.237 | 0.254 | 0.269 | 0.298 | 0.309 |
| | 25 | 0.213 | 0.245 | 0.263 | 0.278 | 0.307 | 0.318 |
| | 26 | 0.221 | 0.254 | 0.272 | 0.287 | 0.317 | 0.328 |
| | 27 | 0.229 | 0.263 | 0.281 | 0.296 | 0.326 | 0.337 |
| | 28 | 0.238 | 0.271 | 0.290 | 0.305 | 0.335 | 0.346 |
| | 29 | 0.246 | 0.280 | 0.298 | 0.314 | 0.344 | 0.355 |
| | 30 | 0.254 | 0.289 | 0.307 | 0.323 | 0.353 | 0.364 |
| | 31 | 0.263 | 0.297 | 0.316 | 0.332 | 0.362 | 0.373 |
| | 32 | 0.271 | 0.306 | 0.325 | 0.341 | 0.371 | 0.382 |
| | 33 | 0.279 | 0.315 | 0.334 | 0.349 | 0.380 | 0.391 |
| | 34 | 0.288 | 0.323 | 0.342 | 0.358 | 0.389 | 0.400 |
| | 35 | 0.296 | 0.332 | 0.351 | 0.367 | 0.398 | 0.409 |
| | 36 | 0.304 | 0.340 | 0.360 | 0.376 | 0.407 | 0.418 |
| | 37 | 0.313 | 0.349 | 0.368 | 0.384 | 0.415 | 0.427 |
| | 38 | 0.321 | 0.357 | 0.377 | 0.393 | 0.424 | 0.435 |
| | 39 | 0.329 | 0.366 | 0.385 | 0.402 | 0.433 | 0.444 |
| | 40 | 0.337 | 0.374 | 0.394 | 0.410 | 0.441 | 0.453 |
| | 41 | 0.346 | 0.383 | 0.403 | 0.419 | 0.450 | 0.462 |
| | 42 | 0.354 | 0.391 | 0.411 | 0.428 | 0.459 | 0.470 |
| | 43 | 0.362 | 0.400 | 0.420 | 0.436 | 0.467 | 0.479 |
| | 44 | 0.371 | 0.408 | 0.428 | 0.445 | 0.476 | 0.487 |
| | 45 | 0.379 | 0.417 | 0.437 | 0.453 | 0.484 | 0.496 |
| | 46 | 0.387 | 0.425 | 0.445 | 0.462 | 0.493 | 0.504 |
| | 47 | 0.396 | 0.433 | 0.453 | 0.470 | 0.501 | 0.513 |
| | 48 | 0.404 | 0.442 | 0.462 | 0.478 | 0.510 | 0.521 |
| | 49 | 0.412 | 0.450 | 0.470 | 0.487 | 0.518 | 0.529 |
| | 50 | 0.421 | 0.459 | 0.479 | 0.495 | 0.526 | 0.538 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 130 | 0 | 0.005 | 0.012 | 0.017 | 0.022 | 0.034 | 0.039 |
| | 1 | 0.012 | 0.022 | 0.029 | 0.035 | 0.049 | 0.055 |
| | 2 | 0.020 | 0.032 | 0.040 | 0.047 | 0.063 | 0.069 |
| | 3 | 0.028 | 0.042 | 0.050 | 0.058 | 0.075 | 0.081 |
| | 4 | 0.035 | 0.051 | 0.060 | 0.069 | 0.086 | 0.093 |
| | 5 | 0.043 | 0.060 | 0.070 | 0.079 | 0.097 | 0.105 |
| | 6 | 0.051 | 0.068 | 0.079 | 0.089 | 0.108 | 0.116 |
| | 7 | 0.058 | 0.077 | 0.088 | 0.098 | 0.118 | 0.126 |
| | 8 | 0.066 | 0.086 | 0.098 | 0.108 | 0.129 | 0.137 |
| | 9 | 0.074 | 0.094 | 0.107 | 0.117 | 0.139 | 0.147 |
| | 10 | 0.081 | 0.103 | 0.116 | 0.126 | 0.148 | 0.157 |
| | 11 | 0.089 | 0.112 | 0.124 | 0.136 | 0.158 | 0.167 |
| | 12 | 0.097 | 0.120 | 0.133 | 0.145 | 0.168 | 0.177 |
| | 13 | 0.104 | 0.128 | 0.142 | 0.154 | 0.177 | 0.186 |
| | 14 | 0.112 | 0.137 | 0.151 | 0.163 | 0.187 | 0.196 |
| | 15 | 0.120 | 0.145 | 0.159 | 0.172 | 0.196 | 0.205 |
| | 16 | 0.127 | 0.153 | 0.168 | 0.180 | 0.205 | 0.215 |
| | 17 | 0.135 | 0.162 | 0.176 | 0.189 | 0.214 | 0.224 |
| | 18 | 0.143 | 0.170 | 0.185 | 0.198 | 0.223 | 0.233 |
| | 19 | 0.150 | 0.178 | 0.193 | 0.207 | 0.232 | 0.242 |
| | 20 | 0.158 | 0.186 | 0.202 | 0.215 | 0.241 | 0.251 |
| | 21 | 0.166 | 0.194 | 0.210 | 0.224 | 0.250 | 0.260 |
| | 22 | 0.173 | 0.202 | 0.219 | 0.232 | 0.259 | 0.269 |
| | 23 | 0.181 | 0.211 | 0.227 | 0.241 | 0.268 | 0.278 |
| | 24 | 0.189 | 0.219 | 0.235 | 0.249 | 0.276 | 0.287 |
| | 25 | 0.196 | 0.227 | 0.243 | 0.258 | 0.285 | 0.295 |
| | 26 | 0.204 | 0.235 | 0.252 | 0.266 | 0.294 | 0.304 |
| | 27 | 0.212 | 0.243 | 0.260 | 0.274 | 0.302 | 0.313 |
| | 28 | 0.219 | 0.251 | 0.268 | 0.283 | 0.311 | 0.321 |
| | 29 | 0.227 | 0.259 | 0.276 | 0.291 | 0.319 | 0.330 |
| | 30 | 0.235 | 0.267 | 0.284 | 0.299 | 0.328 | 0.338 |
| | 31 | 0.242 | 0.275 | 0.293 | 0.307 | 0.336 | 0.347 |
| | 32 | 0.250 | 0.283 | 0.301 | 0.316 | 0.344 | 0.355 |
| | 33 | 0.258 | 0.291 | 0.309 | 0.324 | 0.353 | 0.363 |
| | 34 | 0.265 | 0.299 | 0.317 | 0.332 | 0.361 | 0.372 |
| | 35 | 0.273 | 0.307 | 0.325 | 0.340 | 0.369 | 0.380 |
| | 36 | 0.281 | 0.315 | 0.333 | 0.348 | 0.378 | 0.388 |
| | 37 | 0.289 | 0.323 | 0.341 | 0.356 | 0.386 | 0.397 |
| | 38 | 0.296 | 0.331 | 0.349 | 0.364 | 0.394 | 0.405 |
| | 39 | 0.304 | 0.338 | 0.357 | 0.372 | 0.402 | 0.413 |
| | 40 | 0.312 | 0.346 | 0.365 | 0.380 | 0.410 | 0.421 |
| | 41 | 0.319 | 0.354 | 0.373 | 0.388 | 0.418 | 0.429 |
| | 42 | 0.327 | 0.362 | 0.381 | 0.396 | 0.426 | 0.437 |
| | 43 | 0.335 | 0.370 | 0.389 | 0.404 | 0.434 | 0.445 |
| | 44 | 0.342 | 0.378 | 0.397 | 0.412 | 0.442 | 0.453 |
| | 45 | 0.350 | 0.386 | 0.404 | 0.420 | 0.450 | 0.461 |
| | 46 | 0.358 | 0.393 | 0.412 | 0.428 | 0.458 | 0.469 |
| | 47 | 0.365 | 0.401 | 0.420 | 0.436 | 0.466 | 0.477 |
| | 48 | 0.373 | 0.409 | 0.428 | 0.444 | 0.474 | 0.485 |
| | 49 | 0.381 | 0.417 | 0.436 | 0.452 | 0.482 | 0.493 |
| | 50 | 0.388 | 0.425 | 0.444 | 0.460 | 0.490 | 0.501 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 140 | 0 | 0.004 | 0.011 | 0.016 | 0.021 | 0.032 | 0.037 |
| | 1 | 0.011 | 0.021 | 0.027 | 0.033 | 0.046 | 0.051 |
| | 2 | 0.019 | 0.030 | 0.037 | 0.044 | 0.058 | 0.064 |
| | 3 | 0.026 | 0.039 | 0.047 | 0.054 | 0.069 | 0.076 |
| | 4 | 0.033 | 0.047 | 0.056 | 0.064 | 0.080 | 0.087 |
| | 5 | 0.040 | 0.055 | 0.065 | 0.073 | 0.090 | 0.097 |
| | 6 | 0.047 | 0.064 | 0.074 | 0.082 | 0.100 | 0.108 |
| | 7 | 0.054 | 0.072 | 0.082 | 0.091 | 0.110 | 0.118 |
| | 8 | 0.061 | 0.080 | 0.091 | 0.100 | 0.120 | 0.127 |
| | 9 | 0.068 | 0.088 | 0.099 | 0.109 | 0.129 | 0.137 |
| | 10 | 0.076 | 0.096 | 0.107 | 0.118 | 0.138 | 0.146 |
| | 11 | 0.083 | 0.104 | 0.116 | 0.126 | 0.147 | 0.155 |
| | 12 | 0.090 | 0.111 | 0.124 | 0.135 | 0.156 | 0.165 |
| | 13 | 0.097 | 0.119 | 0.132 | 0.143 | 0.165 | 0.174 |
| | 14 | 0.104 | 0.127 | 0.140 | 0.151 | 0.174 | 0.182 |
| | 15 | 0.111 | 0.135 | 0.148 | 0.160 | 0.183 | 0.191 |
| | 16 | 0.118 | 0.142 | 0.156 | 0.168 | 0.191 | 0.200 |
| | 17 | 0.125 | 0.150 | 0.164 | 0.176 | 0.200 | 0.209 |
| | 18 | 0.133 | 0.158 | 0.172 | 0.184 | 0.208 | 0.217 |
| | 19 | 0.140 | 0.165 | 0.180 | 0.192 | 0.217 | 0.226 |
| | 20 | 0.147 | 0.173 | 0.188 | 0.200 | 0.225 | 0.234 |
| | 21 | 0.154 | 0.181 | 0.196 | 0.208 | 0.233 | 0.243 |
| | 22 | 0.161 | 0.188 | 0.203 | 0.216 | 0.241 | 0.251 |
| | 23 | 0.168 | 0.196 | 0.211 | 0.224 | 0.250 | 0.259 |
| | 24 | 0.175 | 0.203 | 0.219 | 0.232 | 0.258 | 0.267 |
| | 25 | 0.182 | 0.211 | 0.227 | 0.240 | 0.266 | 0.276 |
| | 26 | 0.190 | 0.218 | 0.234 | 0.248 | 0.274 | 0.284 |
| | 27 | 0.197 | 0.226 | 0.242 | 0.256 | 0.282 | 0.292 |
| | 28 | 0.204 | 0.233 | 0.250 | 0.263 | 0.290 | 0.300 |
| | 29 | 0.211 | 0.241 | 0.257 | 0.271 | 0.298 | 0.308 |
| | 30 | 0.218 | 0.248 | 0.265 | 0.279 | 0.306 | 0.316 |
| | 31 | 0.225 | 0.256 | 0.272 | 0.286 | 0.314 | 0.324 |
| | 32 | 0.232 | 0.263 | 0.280 | 0.294 | 0.321 | 0.332 |
| | 33 | 0.239 | 0.271 | 0.287 | 0.302 | 0.329 | 0.339 |
| | 34 | 0.247 | 0.278 | 0.295 | 0.309 | 0.337 | 0.347 |
| | 35 | 0.254 | 0.285 | 0.303 | 0.317 | 0.345 | 0.355 |
| | 36 | 0.261 | 0.293 | 0.310 | 0.325 | 0.352 | 0.363 |
| | 37 | 0.268 | 0.300 | 0.317 | 0.332 | 0.360 | 0.370 |
| | 38 | 0.275 | 0.307 | 0.325 | 0.340 | 0.368 | 0.378 |
| | 39 | 0.282 | 0.315 | 0.332 | 0.347 | 0.375 | 0.386 |
| | 40 | 0.289 | 0.322 | 0.340 | 0.355 | 0.383 | 0.393 |
| | 41 | 0.296 | 0.330 | 0.347 | 0.362 | 0.390 | 0.401 |
| | 42 | 0.304 | 0.337 | 0.355 | 0.370 | 0.398 | 0.409 |
| | 43 | 0.311 | 0.344 | 0.362 | 0.377 | 0.406 | 0.416 |
| | 44 | 0.318 | 0.351 | 0.369 | 0.384 | 0.413 | 0.424 |
| | 45 | 0.325 | 0.359 | 0.377 | 0.392 | 0.420 | 0.431 |
| | 46 | 0.332 | 0.366 | 0.384 | 0.399 | 0.428 | 0.438 |
| | 47 | 0.339 | 0.373 | 0.391 | 0.407 | 0.435 | 0.446 |
| | 48 | 0.346 | 0.381 | 0.399 | 0.414 | 0.443 | 0.453 |
| | 49 | 0.353 | 0.388 | 0.406 | 0.421 | 0.450 | 0.461 |
| | 50 | 0.361 | 0.395 | 0.413 | 0.429 | 0.457 | 0.468 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 150 | 0 | 0.004 | 0.010 | 0.015 | 0.019 | 0.030 | 0.034 |
| | 1 | 0.011 | 0.019 | 0.025 | 0.031 | 0.043 | 0.048 |
| | 2 | 0.017 | 0.028 | 0.035 | 0.041 | 0.054 | 0.060 |
| | 3 | 0.024 | 0.036 | 0.043 | 0.050 | 0.065 | 0.071 |
| | 4 | 0.031 | 0.044 | 0.052 | 0.059 | 0.075 | 0.081 |
| | 5 | 0.037 | 0.052 | 0.060 | 0.068 | 0.085 | 0.091 |
| | 6 | 0.044 | 0.059 | 0.069 | 0.077 | 0.094 | 0.101 |
| | 7 | 0.051 | 0.067 | 0.077 | 0.085 | 0.103 | 0.110 |
| | 8 | 0.057 | 0.075 | 0.085 | 0.094 | 0.112 | 0.119 |
| | 9 | 0.064 | 0.082 | 0.093 | 0.102 | 0.121 | 0.128 |
| | 10 | 0.070 | 0.089 | 0.100 | 0.110 | 0.129 | 0.137 |
| | 11 | 0.077 | 0.097 | 0.108 | 0.118 | 0.138 | 0.145 |
| | 12 | 0.084 | 0.104 | 0.116 | 0.126 | 0.146 | 0.154 |
| | 13 | 0.090 | 0.111 | 0.123 | 0.134 | 0.154 | 0.162 |
| | 14 | 0.097 | 0.119 | 0.131 | 0.142 | 0.163 | 0.171 |
| | 15 | 0.104 | 0.126 | 0.138 | 0.149 | 0.171 | 0.179 |
| | 16 | 0.110 | 0.133 | 0.146 | 0.157 | 0.179 | 0.187 |
| | 17 | 0.117 | 0.140 | 0.153 | 0.165 | 0.187 | 0.195 |
| | 18 | 0.124 | 0.147 | 0.161 | 0.172 | 0.195 | 0.203 |
| | 19 | 0.130 | 0.155 | 0.168 | 0.180 | 0.203 | 0.211 |
| | 20 | 0.137 | 0.162 | 0.176 | 0.187 | 0.211 | 0.219 |
| | 21 | 0.144 | 0.169 | 0.183 | 0.195 | 0.218 | 0.227 |
| | 22 | 0.150 | 0.176 | 0.190 | 0.202 | 0.226 | 0.235 |
| | 23 | 0.157 | 0.183 | 0.197 | 0.210 | 0.234 | 0.243 |
| | 24 | 0.164 | 0.190 | 0.205 | 0.217 | 0.241 | 0.250 |
| | 25 | 0.170 | 0.197 | 0.212 | 0.224 | 0.249 | 0.258 |
| | 26 | 0.177 | 0.204 | 0.219 | 0.232 | 0.256 | 0.266 |
| | 27 | 0.184 | 0.211 | 0.226 | 0.239 | 0.264 | 0.273 |
| | 28 | 0.190 | 0.218 | 0.233 | 0.246 | 0.272 | 0.281 |
| | 29 | 0.197 | 0.225 | 0.241 | 0.254 | 0.279 | 0.288 |
| | 30 | 0.203 | 0.232 | 0.248 | 0.261 | 0.286 | 0.296 |
| | 31 | 0.210 | 0.239 | 0.255 | 0.268 | 0.294 | 0.303 |
| | 32 | 0.217 | 0.246 | 0.262 | 0.275 | 0.301 | 0.31[illegible] |
| | 33 | 0.223 | 0.253 | 0.269 | 0.282 | 0.308 | 0.318 |
| | 34 | 0.230 | 0.260 | 0.276 | 0.290 | 0.316 | 0.326 |
| | 35 | 0.237 | 0.267 | 0.283 | 0.297 | 0.323 | 0.333 |
| | 36 | 0.243 | 0.274 | 0.290 | 0.304 | 0.330 | 0.340 |
| | 37 | 0.250 | 0.281 | 0.297 | 0.311 | 0.338 | 0.347 |
| | 38 | 0.257 | 0.287 | 0.304 | 0.318 | 0.345 | 0.355 |
| | 39 | 0.263 | 0.294 | 0.311 | 0.325 | 0.352 | 0.362 |
| | 40 | 0.270 | 0.301 | 0.318 | 0.332 | 0.359 | 0.369 |
| | 41 | 0.277 | 0.308 | 0.325 | 0.339 | 0.366 | 0.376 |
| | 42 | 0.283 | 0.315 | 0.332 | 0.346 | 0.373 | 0.383 |
| | 43 | 0.290 | 0.322 | 0.339 | 0.353 | 0.380 | 0.390 |
| | 44 | 0.297 | 0.329 | 0.346 | 0.360 | 0.387 | 0.397 |
| | 45 | 0.303 | 0.335 | 0.353 | 0.367 | 0.394 | 0.405 |
| | 46 | 0.310 | 0.342 | 0.360 | 0.374 | 0.401 | 0.412 |
| | 47 | 0.317 | 0.349 | 0.366 | 0.381 | 0.408 | 0.419 |
| | 48 | 0.323 | 0.356 | 0.373 | 0.388 | 0.415 | 0.426 |
| | 49 | 0.330 | 0.363 | 0.380 | 0.395 | 0.422 | 0.433 |
| | 50 | 0.337 | 0.369 | 0.387 | 0.402 | 0.429 | 0.439 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 160 | 0 | 0.004 | 0.010 | 0.014 | 0.018 | 0.028 | 0.032 |
| | 1 | 0.010 | 0.018 | 0.024 | 0.029 | 0.040 | 0.045 |
| | 2 | 0.016 | 0.026 | 0.032 | 0.038 | 0.051 | 0.056 |
| | 3 | 0.022 | 0.034 | 0.041 | 0.047 | 0.061 | 0.066 |
| | 4 | 0.029 | 0.041 | 0.049 | 0.056 | 0.070 | 0.076 |
| | 5 | 0.035 | 0.048 | 0.057 | 0.064 | 0.079 | 0.085 |
| | 6 | 0.041 | 0.056 | 0.064 | 0.072 | 0.088 | 0.094 |
| | 7 | 0.047 | 0.063 | 0.072 | 0.080 | 0.097 | 0.103 |
| | 8 | 0.054 | 0.070 | 0.079 | 0.088 | 0.105 | 0.112 |
| | 9 | 0.060 | 0.077 | 0.087 | 0.096 | 0.113 | 0.120 |
| | 10 | 0.066 | 0.084 | 0.094 | 0.103 | 0.121 | 0.129 |
| | 11 | 0.072 | 0.091 | 0.101 | 0.111 | 0.129 | 0.137 |
| | 12 | 0.079 | 0.098 | 0.109 | 0.118 | 0.137 | 0.145 |
| | 13 | 0.085 | 0.104 | 0.116 | 0.126 | 0.145 | 0.153 |
| | 14 | 0.091 | 0.111 | 0.123 | 0.133 | 0.153 | 0.161 |
| | 15 | 0.097 | 0.118 | 0.130 | 0.140 | 0.161 | 0.168 |
| | 16 | 0.103 | 0.125 | 0.137 | 0.147 | 0.168 | 0.176 |
| | 17 | 0.110 | 0.132 | 0.144 | 0.155 | 0.176 | 0.184 |
| | 18 | 0.166 | 0.138 | 0.151 | 0.162 | 0.183 | 0.191 |
| | 19 | 0.122 | 0.145 | 0.158 | 0.169 | 0.191 | 0.199 |
| | 20 | 0.128 | 0.152 | 0.165 | 0.176 | 0.198 | 0.206 |
| | 21 | 0.135 | 0.158 | 0.172 | 0.183 | 0.205 | 0.214 |
| | 22 | 0.141 | 0.165 | 0.178 | 0.190 | 0.213 | 0.221 |
| | 23 | 0.147 | 0.172 | 0.185 | 0.197 | 0.220 | 0.228 |
| | 24 | 0.153 | 0.178 | 0.192 | 0.204 | 0.227 | 0.236 |
| | 25 | 0.160 | 0.185 | 0.199 | 0.211 | 0.234 | 0.243 |
| | 26 | 0.166 | 0.192 | 0.206 | 0.218 | 0.241 | 0.250 |
| | 27 | 0.172 | 0.198 | 0.212 | 0.225 | 0.248 | 0.257 |
| | 28 | 0.178 | 0.205 | 0.219 | 0.231 | 0.255 | 0.264 |
| | 29 | 0.185 | 0.211 | 0.226 | 0.238 | 0.262 | 0.271 |
| | 30 | 0.191 | 0.218 | 0.233 | 0.245 | 0.269 | 0.279 |
| | 31 | 0.197 | 0.224 | 0.239 | 0.252 | 0.276 | 0.286 |
| | 32 | 0.203 | 0.231 | 0.246 | 0.259 | 0.283 | 0.293 |
| | 33 | 0.209 | 0.237 | 0.253 | 0.265 | 0.290 | 0.300 |
| | 34 | 0.216 | 0.244 | 0.259 | 0.272 | 0.297 | 0.306 |
| | 35 | 0.222 | 0.250 | 0.266 | 0.279 | 0.304 | 0.313 |
| | 36 | 0.228 | 0.257 | 0.272 | 0.286 | 0.311 | 0.320 |
| | 37 | 0.234 | 0.263 | 0.279 | 0.292 | 0.318 | 0.327 |
| | 38 | 0.241 | 0.270 | 0.286 | 0.299 | 0.324 | 0.334 |
| | 39 | 0.247 | 0.276 | 0.292 | 0.306 | 0.331 | 0.341 |
| | 40 | 0.253 | 0.283 | 0.299 | 0.312 | 0.338 | 0.348 |
| | 41 | 0.259 | 0.289 | 0.305 | 0.319 | 0.345 | 0.354 |
| | 42 | 0.266 | 0.296 | 0.312 | 0.325 | 0.351 | 0.361 |
| | 43 | 0.272 | 0.302 | 0.318 | 0.332 | 0.358 | 0.368 |
| | 44 | 0.278 | 0.308 | 0.325 | 0.339 | 0.365 | 0.374 |
| | 45 | 0.284 | 0.315 | 0.331 | 0.345 | 0.371 | 0.381 |
| | 46 | 0.291 | 0.321 | 0.338 | 0.352 | 0.378 | 0.388 |
| | 47 | 0.297 | 0.328 | 0.344 | 0.358 | 0.385 | 0.394 |
| | 48 | 0.303 | 0.334 | 0.351 | 0.365 | 0.391 | 0.401 |
| | 49 | 0.309 | 0.341 | 0.357 | 0.371 | 0.398 | 0.408 |
| | 50 | 0.316 | 0.347 | 0.364 | 0.378 | 0.404 | 0.414 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 170 | 0 | 0.004 | 0.009 | 0.013 | 0.017 | 0.026 | 0.030 |
| | 1 | 0.009 | 0.017 | 0.022 | 0.027 | 0.038 | 0.042 |
| | 2 | 0.015 | 0.025 | 0.031 | 0.036 | 0.048 | 0.053 |
| | 3 | 0.021 | 0.032 | 0.038 | 0.044 | 0.057 | 0.063 |
| | 4 | 0.027 | 0.039 | 0.046 | 0.053 | 0.066 | 0.072 |
| | 5 | 0.033 | 0.046 | 0.053 | 0.060 | 0.075 | 0.081 |
| | 6 | 0.039 | 0.052 | 0.061 | 0.068 | 0.083 | 0.089 |
| | 7 | 0.045 | 0.059 | 0.068 | 0.075 | 0.091 | 0.097 |
| | 8 | 0.050 | 0.066 | 0.075 | 0.083 | 0.099 | 0.105 |
| | 9 | 0.056 | 0.072 | 0.082 | 0.090 | 0.107 | 0.113 |
| | 10 | 0.062 | 0.079 | 0.089 | 0.097 | 0.114 | 0.121 |
| | 11 | 0.068 | 0.085 | 0.096 | 0.104 | 0.122 | 0.129 |
| | 12 | 0.074 | 0.092 | 0.102 | 0.111 | 0.129 | 0.136 |
| | 13 | 0.080 | 0.098 | 0.109 | 0.118 | 0.137 | 0.144 |
| | 14 | 0.086 | 0.105 | 0.116 | 0.125 | 0.144 | 0.151 |
| | 15 | 0.091 | 0.111 | 0.122 | 0.132 | 0.151 | 0.159 |
| | 16 | 0.097 | 0.118 | 0.129 | 0.139 | 0.159 | 0.166 |
| | 17 | 0.103 | 0.124 | 0.136 | 0.146 | 0.166 | 0.173 |
| | 18 | 0.109 | 0.130 | 0.142 | 0.152 | 0.173 | 0.180 |
| | 19 | 0.115 | 0.137 | 0.149 | 0.159 | 0.180 | 0.188 |
| | 20 | 0.121 | 0.143 | 0.155 | 0.166 | 0.187 | 0.195 |
| | 21 | 0.127 | 0.149 | 0.162 | 0.172 | 0.194 | 0.202 |
| | 22 | 0.133 | 0.155 | 0.168 | 0.179 | 0.201 | 0.209 |
| | 23 | 0.138 | 0.162 | 0.175 | 0.186 | 0.207 | 0.216 |
| | 24 | 0.144 | 0.168 | 0.181 | 0.192 | 0.214 | 0.222 |
| | 25 | 0.150 | 0.174 | 0.187 | 0.199 | 0.221 | 0.229 |
| | 26 | 0.156 | 0.180 | 0.194 | 0.205 | 0.228 | 0.236 |
| | 27 | 0.162 | 0.187 | 0.200 | 0.212 | 0.234 | 0.243 |
| | 28 | 0.168 | 0.193 | 0.207 | 0.218 | 0.241 | 0.250 |
| | 29 | 0.174 | 0.199 | 0.213 | 0.225 | 0.248 | 0.256 |
| | 30 | 0.180 | 0.205 | 0.219 | 0.231 | 0.254 | 0.263 |
| | 31 | 0.185 | 0.211 | 0.226 | 0.238 | 0.261 | 0.270 |
| | 32 | 0.191 | 0.217 | 0.232 | 0.244 | 0.267 | 0.276 |
| | 33 | 0.197 | 0.224 | 0.238 | 0.250 | 0.274 | 0.283 |
| | 34 | 0.203 | 0.230 | 0.244 | 0.257 | 0.281 | 0.289 |
| | 35 | 0.209 | 0.236 | 0.251 | 0.263 | 0.287 | 0.296 |
| | 36 | 0.215 | 0.242 | 0.257 | 0.269 | 0.293 | 0.303 |
| | 37 | 0.221 | 0.248 | 0.263 | 0.276 | 0.300 | 0.309 |
| | 38 | 0.227 | 0.254 | 0.269 | 0.282 | 0.306 | 0.315 |
| | 39 | 0.232 | 0.260 | 0.275 | 0.288 | 0.313 | 0.322 |
| | 40 | 0.238 | 0.266 | 0.282 | 0.295 | 0.319 | 0.328 |
| | 41 | 0.244 | 0.273 | 0.288 | 0.301 | 0.326 | 0.335 |
| | 42 | 0.250 | 0.279 | 0.294 | 0.307 | 0.332 | 0.341 |
| | 43 | 0.256 | 0.285 | 0.300 | 0.313 | 0.338 | 0.348 |
| | 44 | 0.262 | 0.291 | 0.306 | 0.319 | 0.345 | 0.354 |
| | 45 | 0.268 | 0.297 | 0.312 | 0.326 | 0.351 | 0.360 |
| | 46 | 0.273 | 0.303 | 0.319 | 0.332 | 0.357 | 0.366 |
| | 47 | 0.279 | 0.309 | 0.325 | 0.338 | 0.363 | 0.373 |
| | 48 | 0.285 | 0.315 | 0.331 | 0.344 | 0.370 | 0.379 |
| | 49 | 0.291 | 0.321 | 0.337 | 0.350 | 0.376 | 0.385 |
| | 50 | 0.297 | 0.327 | 0.343 | 0.356 | 0.382 | 0.392 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 180 | 0 | 0.003 | 0.008 | 0.012 | 0.016 | 0.025 | 0.029 |
| | 1 | 0.009 | 0.016 | 0.021 | 0.026 | 0.036 | 0.040 |
| | 2 | 0.014 | 0.023 | 0.029 | 0.034 | 0.045 | 0.050 |
| | 3 | 0.020 | 0.030 | 0.036 | 0.042 | 0.054 | 0.059 |
| | 4 | 0.025 | 0.037 | 0.043 | 0.050 | 0.063 | 0.068 |
| | 5 | 0.031 | 0.043 | 0.050 | 0.057 | 0.071 | 0.076 |
| | 6 | 0.036 | 0.049 | 0.057 | 0.064 | 0.079 | 0.084 |
| | 7 | 0.042 | 0.056 | 0.064 | 0.071 | 0.086 | 0.092 |
| | 8 | 0.048 | 0.062 | 0.071 | 0.078 | 0.094 | 0.100 |
| | 9 | 0.053 | 0.068 | 0.077 | 0.085 | 0.101 | 0.107 |
| | 10 | 0.059 | 0.075 | 0.084 | 0.092 | 0.108 | 0.115 |
| | 11 | 0.064 | 0.081 | 0.090 | 0.099 | 0.115 | 0.122 |
| | 12 | 0.070 | 0.087 | 0.097 | 0.105 | 0.122 | 0.129 |
| | 13 | 0.075 | 0.093 | 0.103 | 0.112 | 0.129 | 0.136 |
| | 14 | 0.081 | 0.099 | 0.109 | 0.118 | 0.136 | 0.143 |
| | 15 | 0.086 | 0.105 | 0.116 | 0.125 | 0.143 | 0.150 |
| | 16 | 0.092 | 0.111 | 0.122 | 0.131 | 0.150 | 0.157 |
| | 17 | 0.097 | 0.117 | 0.128 | 0.138 | 0.157 | 0.164 |
| | 18 | 0.103 | 0.123 | 0.134 | 0.144 | 0.163 | 0.171 |
| | 19 | 0.109 | 0.129 | 0.141 | 0.151 | 0.170 | 0.178 |
| | 20 | 0.114 | 0.135 | 0.147 | 0.157 | 0.177 | 0.184 |
| | 21 | 0.120 | 0.141 | 0.153 | 0.163 | 0.183 | 0.191 |
| | 22 | 0.125 | 0.147 | 0.159 | 0.169 | 0.190 | 0.198 |
| | 23 | 0.131 | 0.153 | 0.165 | 0.176 | 0.196 | 0.204 |
| | 24 | 0.136 | 0.159 | 0.171 | 0.182 | 0.203 | 0.211 |
| | 25 | 0.142 | 0.165 | 0.177 | 0.188 | 0.209 | 0.217 |
| | 26 | 0.147 | 0.171 | 0.183 | 0.194 | 0.216 | 0.224 |
| | 27 | 0.153 | 0.176 | 0.189 | 0.200 | 0.222 | 0.230 |
| | 28 | 0.158 | 0.182 | 0.195 | 0.207 | 0.228 | 0.236 |
| | 29 | 0.164 | 0.188 | 0.201 | 0.213 | 0.235 | 0.243 |
| | 30 | 0.170 | 0.194 | 0.207 | 0.219 | 0.241 | 0.249 |
| | 31 | 0.175 | 0.200 | 0.213 | 0.225 | 0.247 | 0.255 |
| | 32 | 0.181 | 0.206 | 0.219 | 0.231 | 0.253 | 0.262 |
| | 33 | 0.186 | 0.211 | 0.225 | 0.237 | 0.259 | 0.268 |
| | 34 | 0.192 | 0.217 | 0.231 | 0.243 | 0.266 | 0.274 |
| | 35 | 0.197 | 0.223 | 0.237 | 0.249 | 0.272 | 0.280 |
| | 36 | 0.203 | 0.229 | 0.243 | 0.255 | 0.278 | 0.287 |
| | 37 | 0.208 | 0.235 | 0.249 | 0.261 | 0.284 | 0.293 |
| | 38 | 0.214 | 0.240 | 0.255 | 0.267 | 0.290 | 0.299 |
| | 39 | 0.219 | 0.246 | 0.261 | 0.273 | 0.296 | 0.305 |
| | 40 | 0.225 | 0.252 | 0.266 | 0.279 | 0.302 | 0.311 |
| | 41 | 0.231 | 0.258 | 0.272 | 0.285 | 0.308 | 0.317 |
| | 42 | 0.236 | 0.263 | 0.278 | 0.291 | 0.314 | 0.323 |
| | 43 | 0.242 | 0.269 | 0.284 | 0.296 | 0.320 | 0.329 |
| | 44 | 0.247 | 0.275 | 0.290 | 0.302 | 0.326 | 0.335 |
| | 45 | 0.253 | 0.281 | 0.296 | 0.308 | 0.332 | 0.341 |
| | 46 | 0.258 | 0.286 | 0.301 | 0.314 | 0.338 | 0.347 |
| | 47 | 0.264 | 0.292 | 0.307 | 0.320 | 0.344 | 0.353 |
| | 48 | 0.269 | 0.298 | 0.313 | 0.326 | 0.350 | 0.359 |
| | 49 | 0.275 | 0.303 | 0.319 | 0.332 | 0.356 | 0.365 |
| | 50 | 0.280 | 0.309 | 0.325 | 0.337 | 0.362 | 0.371 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 190 | 0 | 0.003 | 0.008 | 0.012 | 0.015 | 0.023 | 0.027 |
| | 1 | 0.008 | 0.015 | 0.020 | 0.024 | 0.034 | 0.038 |
| | 2 | 0.014 | 0.022 | 0.027 | 0.032 | 0.043 | 0.047 |
| | 3 | 0.019 | 0.028 | 0.034 | 0.040 | 0.051 | 0.056 |
| | 4 | 0.024 | 0.035 | 0.041 | 0.047 | 0.059 | 0.064 |
| | 5 | 0.029 | 0.041 | 0.048 | 0.054 | 0.067 | 0.072 |
| | 6 | 0.035 | 0.047 | 0.054 | 0.061 | 0.074 | 0.080 |
| | 7 | 0.040 | 0.053 | 0.061 | 0.068 | 0.082 | 0.087 |
| | 8 | 0.045 | 0.059 | 0.067 | 0.074 | 0.089 | 0.095 |
| | 9 | 0.050 | 0.065 | 0.073 | 0.081 | 0.096 | 0.102 |
| | 10 | 0.056 | 0.071 | 0.079 | 0.087 | 0.103 | 0.109 |
| | 11 | 0.061 | 0.076 | 0.086 | 0.094 | 0.110 | 0.116 |
| | 12 | 0.066 | 0.082 | 0.092 | 0.100 | 0.116 | 0.123 |
| | 13 | 0.071 | 0.088 | 0.098 | 0.106 | 0.123 | 0.129 |
| | 14 | 0.077 | 0.094 | 0.104 | 0.112 | 0.129 | 0.136 |
| | 15 | 0.082 | 0.100 | 0.110 | 0.118 | 0.136 | 0.143 |
| | 16 | 0.087 | 0.105 | 0.116 | 0.125 | 0.142 | 0.149 |
| | 17 | 0.092 | 0.111 | 0.122 | 0.131 | 0.149 | 0.156 |
| | 18 | 0.098 | 0.117 | 0.127 | 0.137 | 0.155 | 0.162 |
| | 19 | 0.103 | 0.122 | 0.133 | 0.143 | 0.161 | 0.169 |
| | 20 | 0.108 | 0.128 | 0.139 | 0.149 | 0.168 | 0.175 |
| | 21 | 0.113 | 0.134 | 0.145 | 0.155 | 0.174 | 0.181 |
| | 22 | 0.119 | 0.139 | 0.151 | 0.161 | 0.180 | 0.188 |
| | 23 | 0.124 | 0.145 | 0.157 | 0.167 | 0.186 | 0.194 |
| | 24 | 0.129 | 0.150 | 0.162 | 0.173 | 0.192 | 0.200 |
| | 25 | 0.134 | 0.156 | 0.168 | 0.178 | 0.199 | 0.206 |
| | 26 | 0.140 | 0.162 | 0.174 | 0.184 | 0.205 | 0.212 |
| | 27 | 0.145 | 0.167 | 0.180 | 0.190 | 0.211 | 0.218 |
| | 28 | 0.150 | 0.173 | 0.185 | 0.196 | 0.217 | 0.225 |
| | 29 | 0.155 | 0.178 | 0.191 | 0.202 | 0.223 | 0.231 |
| | 30 | 0.161 | 0.184 | 0.197 | 0.208 | 0.229 | 0.237 |
| | 31 | 0.166 | 0.189 | 0.202 | 0.213 | 0.235 | 0.243 |
| | 32 | 0.171 | 0.195 | 0.208 | 0.219 | 0.241 | 0.249 |
| | 33 | 0.176 | 0.200 | 0.214 | 0.225 | 0.246 | 0.255 |
| | 34 | 0.182 | 0.206 | 0.219 | 0.231 | 0.252 | 0.261 |
| | 35 | 0.187 | 0.211 | 0.225 | 0.236 | 0.258 | 0.266 |
| | 36 | 0.192 | 0.217 | 0.230 | 0.242 | 0.264 | 0.272 |
| | 37 | 0.197 | 0.222 | 0.236 | 0.248 | 0.270 | 0.278 |
| | 38 | 0.203 | 0.228 | 0.242 | 0.253 | 0.276 | 0.284 |
| | 39 | 0.208 | 0.233 | 0.247 | 0.259 | 0.281 | 0.290 |
| | 40 | 0.213 | 0.239 | 0.253 | 0.265 | 0.287 | 0.296 |
| | 41 | 0.218 | 0.244 | 0.258 | 0.270 | 0.293 | 0.301 |
| | 42 | 0.224 | 0.250 | 0.264 | 0.276 | 0.299 | 0.307 |
| | 43 | 0.229 | 0.255 | 0.269 | 0.281 | 0.304 | 0.313 |
| | 44 | 0.234 | 0.261 | 0.275 | 0.287 | 0.310 | 0.319 |
| | 45 | 0.239 | 0.266 | 0.280 | 0.293 | 0.316 | 0.325 |
| | 46 | 0.245 | 0.272 | 0.286 | 0.298 | 0.322 | 0.330 |
| | 47 | 0.250 | 0.277 | 0.292 | 0.304 | 0.327 | 0.336 |
| | 48 | 0.255 | 0.282 | 0.297 | 0.309 | 0.333 | 0.342 |
| | 49 | 0.260 | 0.288 | 0.303 | 0.315 | 0.338 | 0.347 |
| | 50 | 0.266 | 0.293 | 0.308 | 0.320 | 0.344 | 0.353 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 200 | 0 | 0.003 | 0.008 | 0.011 | 0.014 | 0.022 | 0.026 |
| | 1 | 0.008 | 0.014 | 0.019 | 0.023 | 0.032 | 0.036 |
| | 2 | 0.013 | 0.021 | 0.026 | 0.031 | 0.041 | 0.045 |
| | 3 | 0.018 | 0.027 | 0.033 | 0.038 | 0.049 | 0.053 |
| | 4 | 0.023 | 0.033 | 0.039 | 0.045 | 0.056 | 0.061 |
| | 5 | 0.028 | 0.039 | 0.045 | 0.051 | 0.064 | 0.069 |
| | 6 | 0.033 | 0.045 | 0.052 | 0.058 | 0.071 | 0.076 |
| | 7 | 0.038 | 0.050 | 0.058 | 0.064 | 0.078 | 0.083 |
| | 8 | 0.043 | 0.056 | 0.064 | 0.071 | 0.084 | 0.090 |
| | 9 | 0.048 | 0.062 | 0.070 | 0.077 | 0.091 | 0.097 |
| | 10 | 0.053 | 0.067 | 0.075 | 0.083 | 0.098 | 0.103 |
| | 11 | 0.058 | 0.073 | 0.081 | 0.089 | 0.104 | 0.110 |
| | 12 | 0.063 | 0.078 | 0.087 | 0.095 | 0.111 | 0.117 |
| | 13 | 0.068 | 0.084 | 0.093 | 0.101 | 0.117 | 0.123 |
| | 14 | 0.073 | 0.089 | 0.099 | 0.107 | 0.123 | 0.129 |
| | 15 | 0.078 | 0.095 | 0.104 | 0.113 | 0.129 | 0.136 |
| | 16 | 0.083 | 0.100 | 0.110 | 0.118 | 0.135 | 0.142 |
| | 17 | 0.088 | 0.105 | 0.116 | 0.124 | 0.142 | 0.148 |
| | 18 | 0.093 | 0.111 | 0.121 | 0.130 | 0.148 | 0.154 |
| | 19 | 0.098 | 0.116 | 0.127 | 0.136 | 0.154 | 0.160 |
| | 20 | 0.103 | 0.122 | 0.132 | 0.141 | 0.160 | 0.166 |
| | 21 | 0.108 | 0.127 | 0.138 | 0.147 | 0.166 | 0.173 |
| | 22 | 0.113 | 0.132 | 0.143 | 0.153 | 0.171 | 0.179 |
| | 23 | 0.118 | 0.138 | 0.149 | 0.158 | 0.177 | 0.184 |
| | 24 | 0.123 | 0.143 | 0.154 | 0.164 | 0.183 | 0.190 |
| | 25 | 0.128 | 0.148 | 0.160 | 0.170 | 0.189 | 0.196 |
| | 26 | 0.133 | 0.154 | 0.165 | 0.175 | 0.195 | 0.202 |
| | 27 | 0.138 | 0.159 | 0.171 | 0.181 | 0.201 | 0.208 |
| | 28 | 0.143 | 0.164 | 0.176 | 0.186 | 0.206 | 0.214 |
| | 29 | 0.148 | 0.170 | 0.182 | 0.192 | 0.212 | 0.220 |
| | 30 | 0.153 | 0.175 | 0.187 | 0.197 | 0.218 | 0.225 |
| | 31 | 0.158 | 0.180 | 0.192 | 0.203 | 0.223 | 0.231 |
| | 32 | 0.163 | 0.185 | 0.198 | 0.208 | 0.229 | 0.237 |
| | 33 | 0.168 | 0.191 | 0.203 | 0.214 | 0.235 | 0.242 |
| | 34 | 0.173 | 0.196 | 0.209 | 0.219 | 0.240 | 0.248 |
| | 35 | 0.178 | 0.201 | 0.214 | 0.225 | 0.246 | 0.254 |
| | 36 | 0.183 | 0.206 | 0.219 | 0.230 | 0.251 | 0.259 |
| | 37 | 0.188 | 0.211 | 0.225 | 0.236 | 0.257 | 0.265 |
| | 38 | 0.193 | 0.217 | 0.230 | 0.241 | 0.262 | 0.271 |
| | 39 | 0.198 | 0.222 | 0.235 | 0.246 | 0.268 | 0.276 |
| | 40 | 0.203 | 0.227 | 0.240 | 0.252 | 0.274 | 0.282 |
| | 41 | 0.207 | 0.232 | 0.246 | 0.257 | 0.279 | 0.287 |
| | 42 | 0.212 | 0.237 | 0.251 | 0.262 | 0.285 | 0.293 |
| | 43 | 0.217 | 0.243 | 0.256 | 0.268 | 0.290 | 0.298 |
| | 44 | 0.222 | 0.248 | 0.262 | 0.273 | 0.295 | 0.304 |
| | 45 | 0.227 | 0.253 | 0.267 | 0.278 | 0.301 | 0.309 |
| | 46 | 0.232 | 0.258 | 0.272 | 0.284 | 0.306 | 0.315 |
| | 47 | 0.237 | 0.263 | 0.277 | 0.289 | 0.312 | 0.320 |
| | 48 | 0.242 | 0.269 | 0.283 | 0.294 | 0.317 | 0.326 |
| | 49 | 0.247 | 0.274 | 0.288 | 0.300 | 0.322 | 0.331 |
| | 50 | 0.252 | 0.279 | 0.293 | 0.305 | 0.328 | 0.336 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 210 | 0 | 0.003 | 0.007 | 0.010 | 0.014 | 0.021 | 0.024 |
| | 1 | 0.007 | 0.014 | 0.018 | 0.022 | 0.031 | 0.034 |
| | 2 | 0.012 | 0.020 | 0.025 | 0.029 | 0.039 | 0.043 |
| | 3 | 0.017 | 0.026 | 0.031 | 0.036 | 0.047 | 0.051 |
| | 4 | 0.022 | 0.031 | 0.037 | 0.043 | 0.054 | 0.058 |
| | 5 | 0.026 | 0.037 | 0.043 | 0.049 | 0.061 | 0.065 |
| | 6 | 0.031 | 0.042 | 0.049 | 0.055 | 0.067 | 0.072 |
| | 7 | 0.036 | 0.048 | 0.055 | 0.061 | 0.074 | 0.079 |
| | 8 | 0.041 | 0.053 | 0.061 | 0.067 | 0.081 | 0.086 |
| | 9 | 0.045 | 0.059 | 0.066 | 0.073 | 0.087 | 0.092 |
| | 10 | 0.050 | 0.064 | 0.072 | 0.079 | 0.093 | 0.099 |
| | 11 | 0.055 | 0.069 | 0.077 | 0.085 | 0.099 | 0.105 |
| | 12 | 0.060 | 0.074 | 0.083 | 0.090 | 0.105 | 0.111 |
| | 13 | 0.064 | 0.080 | 0.088 | 0.096 | 0.111 | 0.117 |
| | 14 | 0.069 | 0.085 | 0.094 | 0.102 | 0.117 | 0.123 |
| | 15 | 0.074 | 0.090 | 0.099 | 0.107 | 0.123 | 0.129 |
| | 16 | 0.079 | 0.095 | 0.105 | 0.113 | 0.129 | 0.135 |
| | 17 | 0.083 | 0.101 | 0.110 | 0.118 | 0.135 | 0.141 |
| | 18 | 0.088 | 0.106 | 0.115 | 0.124 | 0.141 | 0.147 |
| | 19 | 0.093 | 0.111 | 0.121 | 0.129 | 0.147 | 0.153 |
| | 20 | 0.098 | 0.116 | 0.126 | 0.135 | 0.152 | 0.159 |
| | 21 | 0.103 | 0.121 | 0.131 | 0.140 | 0.158 | 0.165 |
| | 22 | 0.107 | 0.126 | 0.137 | 0.146 | 0.164 | 0.170 |
| | 23 | 0.112 | 0.131 | 0.142 | 0.151 | 0.169 | 0.176 |
| | 24 | 0.117 | 0.136 | 0.147 | 0.156 | 0.175 | 0.182 |
| | 25 | 0.122 | 0.141 | 0.152 | 0.162 | 0.180 | 0.187 |
| | 26 | 0.126 | 0.146 | 0.158 | 0.167 | 0.186 | 0.193 |
| | 27 | 0.131 | 0.151 | 0.163 | 0.172 | 0.191 | 0.198 |
| | 28 | 0.136 | 0.156 | 0.168 | 0.178 | 0.197 | 0.204 |
| | 29 | 0.141 | 0.162 | 0.173 | 0.183 | 0.202 | 0.210 |
| | 30 | 0.145 | 0.167 | 0.178 | 0.188 | 0.208 | 0.215 |
| | 31 | 0.150 | 0.172 | 0.183 | 0.193 | 0.213 | 0.221 |
| | 32 | 0.155 | 0.177 | 0.189 | 0.199 | 0.219 | 0.226 |
| | 33 | 0.160 | 0.182 | 0.194 | 0.204 | 0.224 | 0.231 |
| | 34 | 0.164 | 0.187 | 0.199 | 0.209 | 0.229 | 0.237 |
| | 35 | 0.169 | 0.192 | 0.204 | 0.214 | 0.235 | 0.242 |
| | 36 | 0.174 | 0.197 | 0.209 | 0.220 | 0.240 | 0.248 |
| | 37 | 0.179 | 0.202 | 0.214 | 0.225 | 0.245 | 0.253 |
| | 38 | 0.183 | 0.206 | 0.219 | 0 230 | 0.251 | 0.258 |
| | 39 | 0.188 | 0.211 | 0.224 | 0.235 | 0.256 | 0.264 |
| | 40 | 0.193 | 0.216 | 0.229 | 0.240 | 0.261 | 0.269 |
| | 41 | 0.198 | 0.221 | 0.234 | 0.245 | 0.266 | 0.274 |
| | 42 | 0.202 | 0.226 | 0.239 | 0.250 | 0.272 | 0.279 |
| | 43 | 0.207 | 0.231 | 0.244 | 0.255 | 0.277 | 0.285 |
| | 44 | 0.212 | 0.236 | 0.249 | 0.261 | 0.282 | 0.290 |
| | 45 | 0.217 | 0.241 | 0.254 | 0.266 | 0.287 | 0.295 |
| | 46 | 0.221 | 0.246 | 0.259 | 0.271 | 0.292 | 0.300 |
| | 47 | 0.226 | 0.251 | 0.264 | 0.276 | 0.298 | 0.306 |
| | 48 | 0.231 | 0.256 | 0.269 | 0.281 | 0.303 | 0.311 |
| | 49 | 0.236 | 0.261 | 0.274 | 0.286 | 0.308 | 0.316 |
| | 50 | 0.240 | 0.266 | 0.279 | 0.291 | 0.313 | 0.321 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 220 | 0 | 0.003 | 0.007 | 0.010 | 0.013 | 0.020 | 0.023 |
| | 1 | 0.007 | 0.013 | 0.017 | 0.021 | 0.029 | 0.033 |
| | 2 | 0.012 | 0.019 | 0.024 | 0.028 | 0.037 | 0.041 |
| | 3 | 0.016 | 0.024 | 0.030 | 0.034 | 0.044 | 0.049 |
| | 4 | 0.021 | 0.030 | 0.036 | 0.041 | 0.051 | 0.056 |
| | 5 | 0.025 | 0.035 | 0.041 | 0.047 | 0.058 | 0.062 |
| | 6 | 0.030 | 0.040 | 0.047 | 0.053 | 0.064 | 0.069 |
| | 7 | 0.034 | 0.046 | 0.052 | 0.058 | 0.071 | 0.076 |
| | 8 | 0.039 | 0.051 | 0.058 | 0.064 | 0.077 | 0.082 |
| | 9 | 0.043 | 0.056 | 0.063 | 0.070 | 0.083 | 0.088 |
| | 10 | 0.048 | 0.061 | 0.069 | 0.075 | 0.089 | 0.094 |
| | 11 | 0.052 | 0.066 | 0.074 | 0.081 | 0.095 | 0.100 |
| | 12 | 0.057 | 0.071 | 0.079 | 0.086 | 0.101 | 0.106 |
| | 13 | 0.062 | 0.076 | 0.085 | 0.092 | 0.106 | 0.112 |
| | 14 | 0.066 | 0.081 | 0.090 | 0.097 | 0.112 | 0.118 |
| | 15 | 0.071 | 0.086 | 0.095 | 0.103 | 0.118 | 0.124 |
| | 16 | 0.075 | 0.091 | 0.100 | 0.108 | 0.123 | 0.129 |
| | 17 | 0.080 | 0.096 | 0.105 | 0.113 | 0.129 | 0.135 |
| | 18 | 0.084 | 0.101 | 0.110 | 0.118 | 0.135 | 0.141 |
| | 19 | 0.089 | 0.106 | 0.115 | 0.124 | 0.140 | 0.146 |
| | 20 | 0.093 | 0.111 | 0.120 | 0.129 | 0.145 | 0.152 |
| | 21 | 0.098 | 0.116 | 0.125 | 0.134 | 0.151 | 0.157 |
| | 22 | 0.102 | 0.120 | 0.131 | 0.139 | 0.156 | 0.163 |
| | 23 | 0.107 | 0.125 | 0.136 | 0.144 | 0.162 | 0.168 |
| | 24 | 0.111 | 0.130 | 0.141 | 0.149 | 0.167 | 0.174 |
| | 25 | 0.116 | 0.135 | 0.146 | 0.155 | 0.172 | 0.179 |
| | 26 | 0.121 | 0.140 | 0.151 | 0.160 | 0.178 | 0.184 |
| | 27 | 0.125 | 0.145 | 0.155 | 0.165 | 0.183 | 0.190 |
| | 28 | 0.130 | 0.149 | 0.160 | 0.170 | 0.188 | 0.195 |
| | 29 | 0.134 | 0.154 | 0.165 | 0.175 | 0.193 | 0.200 |
| | 30 | 0.139 | 0.159 | 0.170 | 0.180 | 0.199 | 0.206 |
| | 31 | 0.143 | 0.164 | 0.175 | 0.185 | 0.204 | 0.211 |
| | 32 | 0.148 | 0.169 | 0.180 | 0.190 | 0.209 | 0.216 |
| | 33 | 0.152 | 0.173 | 0.185 | 0.195 | 0.214 | 0.221 |
| | 34 | 0.157 | 0.178 | 0.190 | 0.200 | 0.219 | 0.226 |
| | 35 | 0.161 | 0.183 | 0.195 | 0.205 | 0.224 | 0.232 |
| | 36 | 0.166 | 0.188 | 0.200 | 0.210 | 0.229 | 0.237 |
| | 37 | 0.170 | 0.192 | 0.205 | 0.215 | 0.235 | 0.242 |
| | 38 | 0.175 | 0.197 | 0.209 | 0.220 | 0.240 | 0.247 |
| | 39 | 0.180 | 0.202 | 0.214 | 0.225 | 0.245 | 0.252 |
| | 40 | 0.184 | 0.207 | 0.219 | 0.230 | 0.250 | 0.257 |
| | 41 | 0.189 | 0.211 | 0.224 | 0.234 | 0.255 | 0.262 |
| | 42 | 0.193 | 0.216 | 0.229 | 0.239 | 0.260 | 0.267 |
| | 43 | 0.198 | 0.221 | 0.234 | 0.244 | 0.265 | 0.272 |
| | 44 | 0.202 | 0.226 | 0.238 | 0.249 | 0.270 | 0.277 |
| | 45 | 0.207 | 0.230 | 0.243 | 0.254 | 0.275 | 0.282 |
| | 46 | 0.211 | 0.235 | 0.248 | 0.259 | 0.280 | 0.287 |
| | 47 | 0.216 | 0.240 | 0.253 | 0.264 | 0.285 | 0.292 |
| | 48 | 0.220 | 0.244 | 0.258 | 0.268 | 0.290 | 0.297 |
| | 49 | 0.225 | 0.249 | 0.262 | 0.273 | 0.295 | 0.302 |
| | 50 | 0.229 | 0.254 | 0.267 | 0.278 | 0.299 | 0.307 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 230 | 0 | 0.003 | 0.006 | 0.009 | 0.012 | 0.019 | 0.022 |
| | 1 | 0.007 | 0.012 | 0.016 | 0.020 | 0.028 | 0.031 |
| | 2 | 0.011 | 0.018 | 0.022 | 0.027 | 0.036 | 0.039 |
| | 3 | 0.015 | 0.023 | 0.028 | 0.033 | 0.043 | 0.046 |
| | 4 | 0.020 | 0.029 | 0.034 | 0.039 | 0.049 | 0.053 |
| | 5 | 0.024 | 0.034 | 0.039 | 0.045 | 0.055 | 0.060 |
| | 6 | 0.028 | 0.039 | 0.045 | 0.050 | 0.062 | 0.066 |
| | 7 | 0.033 | 0.044 | 0.050 | 0.056 | 0.068 | 0.072 |
| | 8 | 0.037 | 0.049 | 0.055 | 0.061 | 0.074 | 0.078 |
| | 9 | 0.041 | 0.054 | 0.061 | 0.067 | 0.079 | 0.084 |
| | 10 | 0.046 | 0.058 | 0.066 | 0.072 | 0.085 | 0.090 |
| | 11 | 0.050 | 0.063 | 0.071 | 0.077 | 0.091 | 0.096 |
| | 12 | 0.054 | 0.068 | 0.076 | 0.083 | 0.096 | 0.102 |
| | 13 | 0.059 | 0.073 | 0.081 | 0.088 | 0.102 | 0.107 |
| | 14 | 0.063 | 0.078 | 0.086 | 0.093 | 0.107 | 0.113 |
| | 15 | 0.068 | 0.082 | 0.091 | 0.098 | 0.113 | 0.118 |
| | 16 | 0.072 | 0.087 | 0.096 | 0.103 | 0.118 | 0.124 |
| | 17 | 0.076 | 0.092 | 0.101 | 0.108 | 0.124 | 0.129 |
| | 18 | 0.081 | 0.097 | 0.106 | 0.113 | 0.129 | 0.135 |
| | 19 | 0.085 | 0.101 | 0.110 | 0.118 | 0.134 | 0.140 |
| | 20 | 0.089 | 0.106 | 0.115 | 0.123 | 0.139 | 0.145 |
| | 21 | 0.094 | 0.111 | 0.120 | 0.128 | 0.145 | 0.151 |
| | 22 | 0.098 | 0.115 | 0.125 | 0.133 | 0.150 | 0.156 |
| | 23 | 0.102 | 0.120 | 0.130 | 0.138 | 0.155 | 0.161 |
| | 24 | 0.107 | 0.125 | 0.135 | 0.143 | 0.160 | 0.166 |
| | 25 | 0.111 | 0.129 | 0.139 | 0.148 | 0.165 | 0.172 |
| | 26 | 0.115 | 0.134 | 0.144 | 0.153 | 0.170 | 0.177 |
| | 27 | 0.120 | 0.138 | 0.149 | 0.158 | 0.175 | 0.182 |
| | 28 | 0.124 | 0.143 | 0.154 | 0.163 | 0.180 | 0.187 |
| | 29 | 0.128 | 0.148 | 0.158 | 0.167 | 0.185 | 0.192 |
| | 30 | 0.133 | 0.152 | 0.163 | 0.172 | 0.190 | 0.197 |
| | 31 | 0.137 | 0.157 | 0.168 | 0.177 | 0.195 | 0.202 |
| | 32 | 0.141 | 0.161 | 0.172 | 0.182 | 0.200 | 0.207 |
| | 33 | 0.146 | 0.166 | 0.177 | 0.187 | 0.205 | 0.212 |
| | 34 | 0.150 | 0.171 | 0.182 | 0.191 | 0.210 | 0.217 |
| | 35 | 0.154 | 0.175 | 0.186 | 0.196 | 0.215 | 0.222 |
| | 36 | 0.159 | 0.180 | 0.191 | 0.201 | 0.220 | 0.227 |
| | 37 | 0.163 | 0.184 | 0.196 | 0.206 | 0.225 | 0.232 |
| | 38 | 0.167 | 0.189 | 0.200 | 0.210 | 0.230 | 0.237 |
| | 39 | 0.172 | 0.193 | 0.205 | 0.215 | 0.234 | 0.242 |
| | 40 | 0.176 | 0.198 | 0.210 | 0.220 | 0.239 | 0.247 |
| | 41 | 0.180 | 0.202 | 0.214 | 0.224 | 0.244 | 0.251 |
| | 42 | 0.185 | 0.207 | 0.219 | 0.229 | 0.249 | 0.256 |
| | 43 | 0.189 | 0.211 | 0.224 | 0.234 | 0.254 | 0.261 |
| | 44 | 0.193 | 0.216 | 0.228 | 0.239 | 0.258 | 0.266 |
| | 45 | 0.198 | 0.220 | 0.233 | 0.243 | 0.263 | 0.271 |
| | 46 | 0.202 | 0.225 | 0.237 | 0.248 | 0.268 | 0.276 |
| | 47 | 0.206 | 0.229 | 0.242 | 0.253 | 0.273 | 0.280 |
| | 48 | 0.211 | 0.234 | 0.247 | 0.257 | 0.278 | 0.285 |
| | 49 | 0.215 | 0.238 | 0.251 | 0.262 | 0.282 | 0.290 |
| | 50 | 0.219 | 0.243 | 0.256 | 0.266 | 0.287 | 0.295 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 240 | 0 | 0.002 | 0.006 | 0.009 | 0.012 | 0.019 | 0.021 |
| | 1 | 0.006 | 0.012 | 0.016 | 0.019 | 0.027 | 0.030 |
| | 2 | 0.011 | 0.017 | 0.022 | 0.025 | 0.034 | 0.038 |
| | 3 | 0.015 | 0.022 | 0.027 | 0.031 | 0.041 | 0.044 |
| | 4 | 0.019 | 0.027 | 0.033 | 0.037 | 0.047 | 0.051 |
| | 5 | 0.023 | 0.032 | 0.038 | 0.043 | 0.053 | 0.057 |
| | 6 | 0.027 | 0.037 | 0.043 | 0.048 | 0.059 | 0.063 |
| | 7 | 0.031 | 0.042 | 0.048 | 0.054 | 0.065 | 0.069 |
| | 8 | 0.036 | 0.047 | 0.053 | 0.059 | 0.071 | 0.075 |
| | 9 | 0.040 | 0.051 | 0.058 | 0.064 | 0.076 | 0.081 |
| | 10 | 0.044 | 0.056 | 0.063 | 0.069 | 0.082 | 0.087 |
| | 11 | 0.048 | 0.061 | 0.068 | 0.074 | 0.087 | 0.092 |
| | 12 | 0.052 | 0.065 | 0.073 | 0.079 | 0.092 | 0.098 |
| | 13 | 0.056 | 0.070 | 0.078 | 0.084 | 0.098 | 0.103 |
| | 14 | 0.061 | 0.074 | 0.082 | 0.089 | 0.103 | 0.108 |
| | 15 | 0.065 | 0.079 | 0.087 | 0.094 | 0.108 | 0.114 |
| | 16 | 0.069 | 0.083 | 0.092 | 0.099 | 0.113 | 0.119 |
| | 17 | 0.073 | 0.088 | 0.096 | 0.104 | 0.118 | 0.124 |
| | 18 | 0.077 | 0.093 | 0.101 | 0.109 | 0.124 | 0.129 |
| | 19 | 0.081 | 0.097 | 0.106 | 0.114 | 0.129 | 0.134 |
| | 20 | 0.085 | 0.102 | 0.111 | 0.118 | 0.134 | 0.140 |
| | 21 | 0.090 | 0.106 | 0.115 | 0.123 | 0.139 | 0.145 |
| | 22 | 0.094 | 0.110 | 0.120 | 0.128 | 0.144 | 0.150 |
| | 23 | 0.098 | 0.115 | 0.124 | 0.133 | 0.149 | 0.155 |
| | 24 | 0.102 | 0.119 | 0.129 | 0.137 | 0.153 | 0.160 |
| | 25 | 0.106 | 0.124 | 0.134 | 0.142 | 0.158 | 0.165 |
| | 26 | 0.110 | 0.128 | 0.138 | 0.147 | 0.163 | 0.170 |
| | 27 | 0.115 | 0.133 | 0.143 | 0.151 | 0.168 | 0.174 |
| | 28 | 0.119 | 0.137 | 0.147 | 0.156 | 0.173 | 0.179 |
| | 29 | 0.123 | 0.142 | 0.152 | 0.161 | 0.178 | 0.184 |
| | 30 | 0.127 | 0.146 | 0.156 | 0.165 | 0.183 | 0.189 |
| | 31 | 0.131 | 0.150 | 0.161 | 0.170 | 0.187 | 0.194 |
| | 32 | 0.135 | 0.155 | 0.165 | 0.174 | 0.192 | 0.199 |
| | 33 | 0.140 | 0.159 | 0.170 | 0.179 | 0.197 | 0.204 |
| | 34 | 0.144 | 0.163 | 0.174 | 0.184 | 0.202 | 0.208 |
| | 35 | 0.148 | 0.168 | 0.179 | 0.188 | 0.206 | 0.213 |
| | 36 | 0.152 | 0.172 | 0.183 | 0.193 | 0.211 | 0.218 |
| | 37 | 0.156 | 0.177 | 0.188 | 0.197 | 0.216 | 0.223 |
| | 38 | 0.160 | 0.181 | 0.192 | 0.202 | 0.220 | 0.227 |
| | 39 | 0.165 | 0.185 | 0.197 | 0.206 | 0.225 | 0.232 |
| | 40 | 0.169 | 0.190 | 0.201 | 0.211 | 0.230 | 0.237 |
| | 41 | 0.173 | 0.194 | 0.206 | 0.215 | 0.234 | 0.241 |
| | 42 | 0.177 | 0.198 | 0.210 | 0.220 | 0.239 | 0.246 |
| | 43 | 0.181 | 0.203 | 0.214 | 0.224 | 0.244 | 0.251 |
| | 44 | 0.185 | 0.207 | 0.219 | 0.229 | 0.248 | 0.255 |
| | 45 | 0.190 | 0.211 | 0.223 | 0.233 | 0.253 | 0.260 |
| | 46 | 0.194 | 0.216 | 0.228 | 0.238 | 0.257 | 0.265 |
| | 47 | 0.198 | 0.220 | 0.232 | 0.242 | 0.262 | 0.269 |
| | 48 | 0.202 | 0.224 | 0.237 | 0.247 | 0.266 | 0.274 |
| | 49 | 0.206 | 0.229 | 0.241 | 0.251 | 0.271 | 0.278 |
| | 50 | 0.210 | 0.233 | 0.245 | 0.256 | 0.276 | 0.283 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 250 | 0 | 0.002 | 0.006 | 0.009 | 0.011 | 0.018 | 0.020 |
| | 1 | 0.006 | 0.011 | 0.015 | 0.018 | 0.026 | 0.029 |
| | 2 | 0.010 | 0.017 | 0.021 | 0.024 | 0.033 | 0.036 |
| | 3 | 0.014 | 0.021 | 0.026 | 0.030 | 0.039 | 0.043 |
| | 4 | 0.018 | 0.026 | 0.031 | 0.036 | 0.045 | 0.049 |
| | 5 | 0.022 | 0.031 | 0.036 | 0.041 | 0.051 | 0.055 |
| | 6 | 0.026 | 0.036 | 0.041 | 0.046 | 0.057 | 0.061 |
| | 7 | 0.030 | 0.040 | 0.046 | 0.051 | 0.062 | 0.067 |
| | 8 | 0.034 | 0.045 | 0.051 | 0.056 | 0.068 | 0.072 |
| | 9 | 0.038 | 0.049 | 0.056 | 0.061 | 0.073 | 0.078 |
| | 10 | 0.042 | 0.054 | 0.060 | 0.066 | 0.078 | 0.083 |
| | 11 | 0.046 | 0.058 | 0.065 | 0.071 | 0.084 | 0.088 |
| | 12 | 0.050 | 0.063 | 0.070 | 0.076 | 0.089 | 0.094 |
| | 13 | 0.054 | 0.067 | 0.074 | 0.081 | 0.094 | 0.099 |
| | 14 | 0.058 | 0.071 | 0.079 | 0.086 | 0.099 | 0.104 |
| | 15 | 0.062 | 0.076 | 0.084 | 0.090 | 0.104 | 0.109 |
| | 16 | 0.066 | 0.080 | 0.088 | 0.095 | 0.109 | 0.114 |
| | 17 | 0.070 | 0.084 | 0.093 | 0.100 | 0.114 | 0.119 |
| | 18 | 0.074 | 0.089 | 0.097 | 0.104 | 0.119 | 0.124 |
| | 19 | 0.078 | 0.093 | 0.102 | 0.109 | 0.124 | 0.129 |
| | 20 | 0.082 | 0.097 | 0.106 | 0.114 | 0.128 | 0.134 |
| | 21 | 0.086 | 0.102 | 0.111 | 0.118 | 0.133 | 0.139 |
| | 22 | 0.090 | 0.106 | 0.115 | 0.123 | 0.138 | 0.144 |
| | 23 | 0.094 | 0.110 | 0.119 | 0.127 | 0.143 | 0.149 |
| | 24 | 0.098 | 0.115 | 0.124 | 0.132 | 0.148 | 0.153 |
| | 25 | 0.102 | 0.119 | 0.128 | 0.136 | 0.152 | 0.158 |
| | 26 | 0.106 | 0.123 | 0.133 | 0.141 | 0.157 | 0.163 |
| | 27 | 0.110 | 0.127 | 0.137 | 0.145 | 0.162 | 0.168 |
| | 28 | 0.114 | 0.132 | 0.141 | 0.150 | 0.166 | 0.172 |
| | 29 | 0.118 | 0.136 | 0.146 | 0.154 | 0.171 | 0.177 |
| | 30 | 0.122 | 0.140 | 0.150 | 0.159 | 0.175 | 0.182 |
| | 31 | 0.126 | 0.144 | 0.155 | 0.163 | 0.180 | 0.186 |
| | 32 | 0.130 | 0.149 | 0.159 | 0.168 | 0.185 | 0.191 |
| | 33 | 0.134 | 0.153 | 0.163 | 0.172 | 0.189 | 0.196 |
| | 34 | 0.138 | 0.157 | 0.167 | 0.176 | 0.194 | 0.200 |
| | 35 | 0.142 | 0.161 | 0.172 | 0.181 | 0.198 | 0.205 |
| | 36 | 0.146 | 0.165 | 0.176 | 0.185 | 0.203 | 0.209 |
| | 37 | 0.150 | 0.170 | 0.180 | 0.190 | 0.207 | 0.214 |
| | 38 | 0.154 | 0.174 | 0.185 | 0.194 | 0.212 | 0.219 |
| | 39 | 0.158 | 0.178 | 0.189 | 0.198 | 0.216 | 0.223 |
| | 40 | 0.162 | 0.182 | 0.193 | 0.203 | 0.221 | 0.228 |
| | 41 | 0.166 | 0.186 | 0.198 | 0.207 | 0.225 | 0.232 |
| | 42 | 0.170 | 0.191 | 0.202 | 0.211 | 0.230 | 0.237 |
| | 43 | 0.174 | 0.195 | 0.206 | 0.216 | 0.234 | 0.241 |
| | 44 | 0.178 | 0.199 | 0.210 | 0.220 | 0.239 | 0.246 |
| | 45 | 0.182 | 0.203 | 0.215 | 0.224 | 0.243 | 0.250 |
| | 46 | 0.186 | 0.207 | 0.219 | 0.229 | 0.247 | 0.254 |
| | 47 | 0.190 | 0.211 | 0.223 | 0.233 | 0.252 | 0.259 |
| | 48 | 0.194 | 0.216 | 0.227 | 0.237 | 0.256 | 0.263 |
| | 49 | 0.198 | 0.220 | 0.231 | 0.241 | 0.261 | 0.268 |
| | 50 | 0.202 | 0.224 | 0.236 | 0.246 | 0.265 | 0.272 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 300 | 0 | 0.002 | 0.005 | 0.007 | 0.009 | 0.015 | 0.017 |
| | 1 | 0.005 | 0.009 | 0.012 | 0.015 | 0.021 | 0.024 |
| | 2 | 0.008 | 0.014 | 0.017 | 0.020 | 0.027 | 0.030 |
| | 3 | 0.012 | 0.018 | 0.022 | 0.025 | 0.033 | 0.036 |
| | 4 | 0.015 | 0.022 | 0.026 | 0.030 | 0.038 | 0.041 |
| | 5 | 0.018 | 0.026 | 0.030 | 0.034 | 0.043 | 0.046 |
| | 6 | 0.022 | 0.030 | 0.034 | 0.039 | 0.047 | 0.051 |
| | 7 | 0.025 | 0.033 | 0.038 | 0.043 | 0.052 | 0.056 |
| | 8 | 0.028 | 0.037 | 0.042 | 0.047 | 0.057 | 0.060 |
| | 9 | 0.032 | 0.041 | 0.046 | 0.051 | 0.061 | 0.065 |
| | 10 | 0.035 | 0.045 | 0.050 | 0.055 | 0.066 | 0.069 |
| | 11 | 0.038 | 0.048 | 0.054 | 0.059 | 0.070 | 0.074 |
| | 12 | 0.042 | 0.052 | 0.058 | 0.064 | 0.074 | 0.078 |
| | 13 | 0.045 | 0.056 | 0.062 | 0.068 | 0.078 | 0.083 |
| | 14 | 0.048 | 0.059 | 0.066 | 0.071 | 0.083 | 0.087 |
| | 15 | 0.052 | 0.063 | 0.070 | 0.075 | 0.087 | 0.091 |
| | 16 | 0.055 | 0.067 | 0.074 | 0.079 | 0.091 | 0.096 |
| | 17 | 0.058 | 0.070 | 0.077 | 0.083 | 0.095 | 0.100 |
| | 18 | 0.062 | 0.074 | 0.081 | 0.087 | 0.099 | 0.104 |
| | 19 | 0.065 | 0.078 | 0.085 | 0.091 | 0.103 | 0.108 |
| | 20 | 0.068 | 0.081 | 0.089 | 0.095 | 0.107 | 0.112 |
| | 21 | 0.072 | 0.085 | 0.092 | 0.099 | 0.111 | 0.116 |
| | 22 | 0.075 | 0.088 | 0.096 | 0.103 | 0.115 | 0.120 |
| | 23 | 0.078 | 0.092 | 0.100 | 0.106 | 0.119 | 0.124 |
| | 24 | 0.082 | 0.096 | 0.103 | 0.110 | 0.123 | 0.129 |
| | 25 | 0.085 | 0.099 | 0.107 | 0.114 | 0.127 | 0.133 |
| | 26 | 0.088 | 0.103 | 0.111 | 0.118 | 0.131 | 0.137 |
| | 27 | 0.092 | 0.106 | 0.114 | 0.121 | 0.135 | 0.140 |
| | 28 | 0.095 | 0.110 | 0.118 | 0.125 | 0.139 | 0.144 |
| | 29 | 0.098 | 0.113 | 0.122 | 0.129 | 0.143 | 0.148 |
| | 30 | 0.102 | 0.117 | 0.125 | 0.133 | 0.147 | 0.152 |
| | 31 | 0.105 | 0.120 | 0.129 | 0.136 | 0.151 | 0.156 |
| | 32 | 0.108 | 0.124 | 0.133 | 0.140 | 0.155 | 0.160 |
| | 33 | 0.112 | 0.128 | 0.136 | 0.144 | 0.158 | 0.164 |
| | 34 | 0.115 | 0.131 | 0.140 | 0.148 | 0.162 | 0.168 |
| | 35 | 0.118 | 0.135 | 0.144 | 0.151 | 0.166 | 0.172 |
| | 36 | 0.122 | 0.138 | 0.147 | 0.155 | 0.170 | 0.176 |
| | 37 | 0.125 | 0.142 | 0.151 | 0.159 | 0.174 | 0.179 |
| | 38 | 0.128 | 0.145 | 0.154 | 0.162 | 0.178 | 0.183 |
| | 39 | 0.132 | 0.149 | 0.158 | 0.166 | 0.181 | 0.187 |
| | 40 | 0.135 | 0.152 | 0.162 | 0.170 | 0.185 | 0.191 |
| | 41 | 0.138 | 0.156 | 0.165 | 0.173 | 0.189 | 0.195 |
| | 42 | 0.142 | 0.159 | 0.169 | 0.177 | 0.193 | 0.199 |
| | 43 | 0.145 | 0.163 | 0.172 | 0.180 | 0.196 | 0.202 |
| | 44 | 0.148 | 0.166 | 0.176 | 0.184 | 0.200 | 0.206 |
| | 45 | 0.152 | 0.170 | 0.179 | 0.188 | 0.204 | 0.210 |
| | 46 | 0.155 | 0.173 | 0.183 | 0.191 | 0.207 | 0.214 |
| | 47 | 0.158 | 0.176 | 0.186 | 0.195 | 0.211 | 0.217 |
| | 48 | 0.162 | 0.180 | 0.190 | 0.198 | 0.215 | 0.221 |
| | 49 | 0.165 | 0.183 | 0.194 | 0.202 | 0.219 | 0.225 |
| | 50 | 0.168 | 0.187 | 0.197 | 0.206 | 0.222 | 0.228 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 350 | 0 | 0.001 | 0.004 | 0.006 | 0.008 | 0.013 | 0.015 |
| | 1 | 0.004 | 0.008 | 0.011 | 0.013 | 0.018 | 0.021 |
| | 2 | 0.007 | 0.012 | 0.015 | 0.017 | 0.023 | 0.026 |
| | 3 | 0.010 | 0.015 | 0.018 | 0.022 | 0.028 | 0.031 |
| | 4 | 0.013 | 0.019 | 0.022 | 0.025 | 0.032 | 0.035 |
| | 5 | 0.016 | 0.022 | 0.026 | 0.029 | 0.037 | 0.039 |
| | 6 | 0.019 | 0.025 | 0.029 | 0.033 | 0.041 | 0.044 |
| | 7 | 0.021 | 0.029 | 0.033 | 0.037 | 0.045 | 0.048 |
| | 8 | 0.024 | 0.032 | 0.036 | 0.040 | 0.049 | 0.052 |
| | 9 | 0.027 | 0.035 | 0.040 | 0.044 | 0.052 | 0.056 |
| | 10 | 0.030 | 0.038 | 0.043 | 0.047 | 0.056 | 0.060 |
| | 11 | 0.033 | 0.041 | 0.047 | 0.051 | 0.060 | 0.063 |
| | 12 | 0.036 | 0.045 | 0.050 | 0.054 | 0.064 | 0.067 |
| | 13 | 0.039 | 0.048 | 0.053 | 0.058 | 0.067 | 0.071 |
| | 14 | 0.041 | 0.051 | 0.057 | 0.061 | 0.071 | 0.075 |
| | 15 | 0.044 | 0.054 | 0.060 | 0.065 | 0.075 | 0.078 |
| | 16 | 0.047 | 0.057 | 0.063 | 0.068 | 0.078 | 0.082 |
| | 17 | 0.050 | 0.060 | 0.066 | 0.071 | 0.082 | 0.086 |
| | 18 | 0.053 | 0.063 | 0.070 | 0.075 | 0.085 | 0.089 |
| | 19 | 0.056 | 0.067 | 0.073 | 0.078 | 0.089 | 0.093 |
| | 20 | 0.058 | 0.070 | 0.076 | 0.081 | 0.092 | 0.096 |
| | 21 | 0.061 | 0.073 | 0.079 | 0.085 | 0.096 | 0.100 |
| | 22 | 0.064 | 0.076 | 0.082 | 0.088 | 0.099 | 0.104 |
| | 23 | 0.067 | 0.079 | 0.086 | 0.091 | 0.103 | 0.107 |
| | 24 | 0.070 | 0.082 | 0.089 | 0.095 | 0.106 | 0.111 |
| | 25 | 0.073 | 0.085 | 0.092 | 0.098 | 0.110 | 0.114 |
| | 26 | 0.076 | 0.088 | 0.095 | 0.101 | 0.113 | 0.117 |
| | 27 | 0.078 | 0.091 | 0.098 | 0.104 | 0.116 | 0.121 |
| | 28 | 0.081 | 0.094 | 0.101 | 0.108 | 0.120 | 0.124 |
| | 29 | 0.084 | 0.097 | 0.105 | 0.111 | 0.123 | 0.128 |
| | 30 | 0.087 | 0.100 | 0.108 | 0.114 | 0.126 | 0.131 |
| | 31 | 0.090 | 0.103 | 0.111 | 0.117 | 0.130 | 0.134 |
| | 32 | 0.093 | 0.106 | 0.114 | 0.120 | 0.133 | 0.138 |
| | 33 | 0.096 | 0.109 | 0.117 | 0.124 | 0.136 | 0.141 |
| | 34 | 0.098 | 0.112 | 0.120 | 0.127 | 0.140 | 0.145 |
| | 35 | 0.101 | 0.115 | 0.123 | 0.130 | 0.143 | 0.148 |
| | 36 | 0.104 | 0.118 | 0.126 | 0.133 | 0.146 | 0.151 |
| | 37 | 0.107 | 0.121 | 0.129 | 0.136 | 0.149 | 0.154 |
| | 38 | 0.110 | 0.124 | 0.133 | 0.139 | 0.153 | 0.158 |
| | 39 | 0.113 | 0.127 | 0.136 | 0.143 | 0.156 | 0.161 |
| | 40 | 0.116 | 0.130 | 0.139 | 0.146 | 0.159 | 0.164 |
| | 41 | 0.118 | 0.133 | 0.142 | 0.149 | 0.162 | 0.168 |
| | 42 | 0.121 | 0.136 | 0.145 | 0.152 | 0.166 | 0.171 |
| | 43 | 0.124 | 0.139 | 0.148 | 0.155 | 0.169 | 0.174 |
| | 44 | 0.127 | 0.142 | 0.151 | 0.158 | 0.172 | 0.177 |
| | 45 | 0.130 | 0.145 | 0.154 | 0.161 | 0.175 | 0.181 |
| | 46 | 0.133 | 0.148 | 0.157 | 0.164 | 0.179 | 0.184 |
| | 47 | 0.136 | 0.151 | 0.160 | 0.168 | 0.182 | 0.187 |
| | 48 | 0.138 | 0.154 | 0.163 | 0.171 | 0.185 | 0.190 |
| | 49 | 0.141 | 0.157 | 0.166 | 0.174 | 0.188 | 0.194 |
| | 50 | 0.144 | 0.160 | 0.169 | 0.177 | 0.191 | 0.197 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 400 | 0 | 0.001 | 0.004 | 0.005 | 0.007 | 0.011 | 0.013 |
| | 1 | 0.004 | 0.007 | 0.009 | 0.011 | 0.016 | 0.018 |
| | 2 | 0.006 | 0.010 | 0.013 | 0.015 | 0.020 | 0.022 |
| | 3 | 0.009 | 0.013 | 0.016 | 0.019 | 0.024 | 0.027 |
| | 4 | 0.011 | 0.016 | 0.019 | 0.022 | 0.028 | 0.031 |
| | 5 | 0.014 | 0.019 | 0.023 | 0.026 | 0.032 | 0.034 |
| | 6 | 0.016 | 0.022 | 0.026 | 0.029 | 0.036 | 0.038 |
| | 7 | 0.019 | 0.025 | 0.029 | 0.032 | 0.039 | 0.042 |
| | 8 | 0.021 | 0.028 | 0.032 | 0.035 | 0.042 | 0.045 |
| | 9 | 0.024 | 0.031 | 0.035 | 0.038 | 0.046 | 0.049 |
| | 10 | 0.026 | 0.033 | 0.038 | 0.042 | 0.049 | 0.052 |
| | 11 | 0.029 | 0.036 | 0.041 | 0.045 | 0.053 | 0.056 |
| | 12 | 0.031 | 0.039 | 0.044 | 0.048 | 0.056 | 0.059 |
| | 13 | 0.034 | 0.042 | 0.047 | 0.051 | 0.059 | 0.062 |
| | 14 | 0.036 | 0.045 | 0.049 | 0.054 | 0.062 | 0.066 |
| | 15 | 0.039 | 0.047 | 0.052 | 0.057 | 0.065 | 0.069 |
| | 16 | 0.041 | 0.050 | 0.055 | 0.060 | 0.069 | 0.072 |
| | 17 | 0.044 | 0.053 | 0.058 | 0.063 | 0.072 | 0.075 |
| | 18 | 0.046 | 0.056 | 0.061 | 0.066 | 0.075 | 0.078 |
| | 19 | 0.049 | 0.058 | 0.064 | 0.068 | 0.078 | 0.081 |
| | 20 | 0.051 | 0.061 | 0.067 | 0.071 | 0.081 | 0.085 |
| | 21 | 0.054 | 0.064 | 0.069 | 0.074 | 0.084 | 0.088 |
| | 22 | 0.056 | 0.066 | 0.072 | 0.077 | 0.087 | 0.091 |
| | 23 | 0.059 | 0.069 | 0.075 | 0.080 | 0.090 | 0.094 |
| | 24 | 0.061 | 0.072 | 0.078 | 0.083 | 0.093 | 0.097 |
| | 25 | 0.064 | 0.074 | 0.080 | 0.086 | 0.096 | 0.100 |
| | 26 | 0.066 | 0.077 | 0.083 | 0.089 | 0.099 | 0.103 |
| | 27 | 0.069 | 0.080 | 0.086 | 0.091 | 0.102 | 0.106 |
| | 28 | 0.071 | 0.082 | 0.089 | 0.094 | 0.105 | 0.109 |
| | 29 | 0.074 | 0.085 | 0.092 | 0.097 | 0.108 | 0.112 |
| | 30 | 0.076 | 0.088 | 0.094 | 0.100 | 0.111 | 0.115 |
| | 31 | 0.079 | 0.090 | 0.097 | 0.103 | 0.114 | 0.118 |
| | 32 | 0.081 | 0.093 | 0.100 | 0.105 | 0.117 | 0.121 |
| | 33 | 0.084 | 0.096 | 0.102 | 0.108 | 0.120 | 0.124 |
| | 34 | 0.086 | 0.098 | 0.105 | 0.111 | 0.122 | 0.127 |
| | 35 | 0.089 | 0.101 | 0.108 | 0.114 | 0.125 | 0.130 |
| | 36 | 0.091 | 0.104 | 0.111 | 0.117 | 0.128 | 0.133 |
| | 37 | 0.094 | 0.106 | 0.113 | 0.119 | 0.131 | 0.136 |
| | 38 | 0.096 | 0.109 | 0.116 | 0.122 | 0.134 | 0.138 |
| | 39 | 0.099 | 0.112 | 0.119 | 0.125 | 0.137 | 0.141 |
| | 40 | 0.101 | 0.114 | 0.122 | 0.128 | 0.140 | 0.144 |
| | 41 | 0.104 | 0.117 | 0.124 | 0.130 | 0.143 | 0.147 |
| | 42 | 0.106 | 0.120 | 0.127 | 0.133 | 0.145 | 0.150 |
| | 43 | 0.109 | 0.122 | 0.130 | 0.136 | 0.148 | 0.153 |
| | 44 | 0.111 | 0.125 | 0.132 | 0.139 | 0.151 | 0.156 |
| | 45 | 0.114 | 0.127 | 0.135 | 0.141 | 0.154 | 0.159 |
| | 46 | 0.116 | 0.130 | 0.138 | 0.144 | 0.157 | 0.162 |
| | 47 | 0.119 | 0.133 | 0.140 | 0.147 | 0.160 | 0.164 |
| | 48 | 0.121 | 0.135 | 0.143 | 0.150 | 0.162 | 0.167 |
| | 49 | 0.124 | 0.138 | 0.146 | 0.152 | 0.165 | 0.170 |
| | 50 | 0.126 | 0.140 | 0.148 | 0.155 | 0.168 | 0.173 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 450 | 0 | 0.001 | 0.003 | 0.005 | 0.006 | 0.010 | 0.011 |
| | 1 | 0.003 | 0.006 | 0.008 | 0.010 | 0.014 | 0.016 |
| | 2 | 0.005 | 0.009 | 0.011 | 0.013 | 0.018 | 0.020 |
| | 3 | 0.008 | 0.012 | 0.014 | 0.017 | 0.022 | 0.024 |
| | 4 | 0.010 | 0.014 | 0.017 | 0.020 | 0.025 | 0.027 |
| | 5 | 0.012 | 0.017 | 0.020 | 0.023 | 0.028 | 0.031 |
| | 6 | 0.014 | 0.020 | 0.023 | 0.026 | 0.032 | 0.034 |
| | 7 | 0.017 | 0.022 | 0.026 | 0.029 | 0.035 | 0.037 |
| | 8 | 0.019 | 0.025 | 0.028 | 0.031 | 0.038 | 0.040 |
| | 9 | 0.021 | 0.027 | 0.031 | 0.034 | 0.041 | 0.043 |
| | 10 | 0.023 | 0.030 | 0.034 | 0.037 | 0.044 | 0.046 |
| | 11 | 0.025 | 0.032 | 0.036 | 0.040 | 0.047 | 0.049 |
| | 12 | 0.028 | 0.035 | 0.039 | 0.042 | 0.050 | 0.052 |
| | 13 | 0.030 | 0.037 | 0.041 | 0.045 | 0.052 | 0.055 |
| | 14 | 0.032 | 0.040 | 0.044 | 0.048 | 0.055 | 0.058 |
| | 15 | 0.034 | 0.042 | 0.046 | 0.050 | 0.058 | 0.061 |
| | 16 | 0.037 | 0.044 | 0.049 | 0.053 | 0.061 | 0.064 |
| | 17 | 0.039 | 0.047 | 0.052 | 0.056 | 0.064 | 0.067 |
| | 18 | 0.041 | 0.049 | 0.054 | 0.058 | 0.067 | 0.070 |
| | 19 | 0.043 | 0.052 | 0.057 | 0.061 | 0.069 | 0.072 |
| | 20 | 0.045 | 0.054 | 0.059 | 0.063 | 0.072 | 0.075 |
| | 21 | 0.048 | 0.057 | 0.062 | 0.066 | 0.075 | 0.078 |
| | 22 | 0.050 | 0.059 | 0.064 | 0.069 | 0.077 | 0.081 |
| | 23 | 0.052 | 0.061 | 0.067 | 0.071 | 0.080 | 0.084 |
| | 24 | 0.054 | 0.064 | 0.069 | 0.074 | 0.083 | 0.086 |
| | 25 | 0.056 | 0.066 | 0.072 | 0.076 | 0.085 | 0.089 |
| | 26 | 0.059 | 0.069 | 0.074 | 0.079 | 0.088 | 0.092 |
| | 27 | 0.061 | 0.071 | 0.076 | 0.081 | 0.091 | 0.094 |
| | 28 | 0.063 | 0.073 | 0.079 | 0.084 | 0.093 | 0.097 |
| | 29 | 0.065 | 0.076 | 0.081 | 0.086 | 0.096 | 0.100 |
| | 30 | 0.068 | 0.078 | 0.084 | 0.089 | 0.099 | 0.102 |
| | 31 | 0.070 | 0.080 | 0.086 | 0.091 | 0.101 | 0.105 |
| | 32 | 0.072 | 0.083 | 0.089 | 0.094 | 0.104 | 0.108 |
| | 33 | 0.074 | 0.085 | 0.091 | 0.096 | 0.106 | 0.110 |
| | 34 | 0.076 | 0.087 | 0.094 | 0.099 | 0.109 | 0.113 |
| | 35 | 0.079 | 0.090 | 0.096 | 0.101 | 0.112 | 0.116 |
| | 36 | 0.081 | 0.092 | 0.098 | 0.104 | 0.114 | 0.118 |
| | 37 | 0.083 | 0.095 | 0.101 | 0.106 | 0.117 | 0.121 |
| | 38 | 0.085 | 0.097 | 0.103 | 0.109 | 0.119 | 0.123 |
| | 39 | 0.088 | 0.099 | 0.106 | 0.111 | 0.122 | 0.126 |
| | 40 | 0.090 | 0.102 | 0.108 | 0.114 | 0.124 | 0.129 |
| | 41 | 0.092 | 0.104 | 0.111 | 0.116 | 0.127 | 0.131 |
| | 42 | 0.094 | 0.106 | 0.113 | 0.119 | 0.130 | 0.134 |
| | 43 | 0.096 | 0.109 | 0.115 | 0.121 | 0.132 | 0.136 |
| | 44 | 0.099 | 0.111 | 0.118 | 0.123 | 0.135 | 0.139 |
| | 45 | 0.101 | 0.113 | 0.120 | 0.126 | 0.137 | 0.141 |
| | 46 | 0.103 | 0.116 | 0.122 | 0.128 | 0.140 | 0.144 |
| | 47 | 0.105 | 0.118 | 0.125 | 0.131 | 0.142 | 0.146 |
| | 48 | 0.108 | 0.120 | 0.127 | 0.133 | 0.145 | 0.149 |
| | 49 | 0.110 | 0.123 | 0.130 | 0.136 | 0.147 | 0.152 |
| | 50 | 0.112 | 0.125 | 0.132 | 0.138 | 0.150 | 0.154 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 500 | 0 | 0.001 | 0.003 | 0.004 | 0.005 | 0.009 | 0.010 |
| | 1 | 0.003 | 0.005 | 0.007 | 0.009 | 0.013 | 0.014 |
| | 2 | 0.005 | 0.008 | 0.010 | 0.012 | 0.016 | 0.018 |
| | 3 | 0.007 | 0.011 | 0.013 | 0.015 | 0.019 | 0.021 |
| | 4 | 0.009 | 0.013 | 0.015 | 0.018 | 0.023 | 0.024 |
| | 5 | 0.011 | 0.015 | 0.018 | 0.020 | 0.026 | 0.028 |
| | 6 | 0.013 | 0.018 | 0.120 | 0.023 | 0.028 | 0.031 |
| | 7 | 0.015 | 0.020 | 0.023 | 0.026 | 0.031 | 0.033 |
| | 8 | 0.017 | 0.022 | 0.025 | 0.028 | 0.034 | 0.036 |
| | 9 | 0.019 | 0.024 | 0.028 | 0.031 | 0.037 | 0.039 |
| | 10 | 0.021 | 0.027 | 0.030 | 0.033 | 0.039 | 0.042 |
| | 11 | 0.023 | 0.029 | 0.033 | 0.036 | 0.042 | 0.045 |
| | 12 | 0.025 | 0.031 | 0.035 | 0.038 | 0.045 | 0.047 |
| | 13 | 0.027 | 0.033 | 0.037 | 0.041 | 0.047 | 0.050 |
| | 14 | 0.029 | 0.036 | 0.040 | 0.043 | 0.050 | 0.052 |
| | 15 | 0.031 | 0.038 | 0.042 | 0.045 | 0.052 | 0.055 |
| | 16 | 0.033 | 0.040 | 0.044 | 0.048 | 0.055 | 0.058 |
| | 17 | 0.035 | 0.042 | 0.046 | 0.050 | 0.057 | 0.060 |
| | 18 | 0.037 | 0.044 | 0.049 | 0.052 | 0.060 | 0.063 |
| | 19 | 0.039 | 0.047 | 0.051 | 0.055 | 0.062 | 0.065 |
| | 20 | 0.041 | 0.049 | 0.053 | 0.057 | 0.065 | 0.068 |
| | 21 | 0.043 | 0.051 | 0.055 | 0.059 | 0.067 | 0.070 |
| | 22 | 0.045 | 0.053 | 0.058 | 0.062 | 0.070 | 0.073 |
| | 23 | 0.047 | 0.055 | 0.060 | 0.064 | 0.072 | 0.075 |
| | 24 | 0.049 | 0.057 | 0.062 | 0.066 | 0.075 | 0.078 |
| | 25 | 0.051 | 0.060 | 0.064 | 0.069 | 0.077 | 0.080 |
| | 26 | 0.053 | 0.062 | 0.067 | 0.071 | 0.079 | 0.083 |
| | 27 | 0.055 | 0.064 | 0.069 | 0.073 | 0.082 | 0.085 |
| | 28 | 0.057 | 0.066 | 0.071 | 0.075 | 0.084 | 0.087 |
| | 29 | 0.059 | 0.068 | 0.073 | 0.078 | 0.087 | 0.090 |
| | 30 | 0.061 | 0.070 | 0.075 | 0.080 | 0.089 | 0.092 |
| | 31 | 0.063 | 0.072 | 0.078 | 0.082 | 0.091 | 0.095 |
| | 32 | 0.065 | 0.074 | 0.080 | 0.085 | 0.094 | 0.097 |
| | 33 | 0.067 | 0.077 | 0.082 | 0.087 | 0.096 | 0.099 |
| | 34 | 0.069 | 0.079 | 0.084 | 0.089 | 0.098 | 0.102 |
| | 35 | 0.071 | 0.081 | 0.086 | 0.091 | 0.101 | 0.104 |
| | 36 | 0.073 | 0.083 | 0.089 | 0.093 | 0.103 | 0.107 |
| | 37 | 0.075 | 0.085 | 0.091 | 0.096 | 0.105 | 0.109 |
| | 38 | 0.077 | 0.087 | 0.093 | 0.098 | 0.108 | 0.111 |
| | 39 | 0.079 | 0.089 | 0.095 | 0.100 | 0.110 | 0.114 |
| | 40 | 0.081 | 0.091 | 0.097 | 0.102 | 0.112 | 0.116 |
| | 41 | 0.083 | 0.094 | 0.100 | 0.105 | 0.114 | 0.118 |
| | 42 | 0.085 | 0.096 | 0.102 | 0.107 | 0.117 | 0.121 |
| | 43 | 0.087 | 0.098 | 0.104 | 0.109 | 0.119 | 0.123 |
| | 44 | 0.089 | 0.100 | 0.106 | 0.111 | 0.121 | 0.125 |
| | 45 | 0.091 | 0.102 | 0.108 | 0.113 | 0.124 | 0.128 |
| | 46 | 0.093 | 0.104 | 0.110 | 0.116 | 0.126 | 0.130 |
| | 47 | 0.095 | 0.106 | 0.112 | 0.118 | 0.128 | 0.132 |
| | 48 | 0.097 | 0.108 | 0.115 | 0.120 | 0.130 | 0.134 |
| | 49 | 0.099 | 0.110 | 0.117 | 0.122 | 0.133 | 0.137 |
| | 50 | 0.101 | 0.112 | 0.119 | 0.124 | 0.135 | 0.139 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 500 | 51 | 0.103 | 0.115 | 0.121 | 0.127 | 0.137 | 0.1[illegible]1 |
| | 52 | 0.105 | 0.117 | 0.123 | 0.129 | 0.139 | 0.144 |
| | 53 | 0.107 | 0.119 | 0.125 | 0.131 | 0.142 | 0.146 |
| | 54 | 0.109 | 0.121 | 0.127 | 0.133 | 0.144 | 0.148 |
| | 55 | 0.111 | 0.123 | 0.130 | 0.135 | 0.146 | 0.150 |
| | 56 | 0.113 | 0.125 | 0.132 | 0.137 | 0.148 | 0.153 |
| | 57 | 0.115 | 0.127 | 0.134 | 0.140 | 0.151 | 0.155 |
| | 58 | 0.117 | 0.129 | 0.136 | 0.142 | 0.153 | 0.157 |
| | 59 | 0.119 | 0.131 | 0.138 | 0.144 | 0.155 | 0.159 |
| | 60 | 0.121 | 0.133 | 0.140 | 0.146 | 0.157 | 0.162 |
| | 61 | 0.123 | 0.135 | 0.142 | 0.148 | 0.160 | 0.164 |
| | 62 | 0.125 | 0.138 | 0.145 | 0.150 | 0.162 | 0.166 |
| | 63 | 0.127 | 0.140 | 0.147 | 0.153 | 0.164 | 0.168 |
| | 64 | 0.129 | 0.142 | 0.149 | 0.155 | 0.166 | 0.171 |
| | 65 | 0.131 | 0.144 | 0.151 | 0.157 | 0.168 | 0.173 |
| | 66 | 0.133 | 0.146 | 0.153 | 0.159 | 0.171 | 0.175 |
| | 67 | 0.135 | 0.148 | 0.155 | 0.161 | 0.173 | 0.177 |
| | 68 | 0.137 | 0.150 | 0.157 | 0.163 | 0.175 | 0.179 |
| | 69 | 0.139 | 0.152 | 0.159 | 0.165 | 0.177 | 0.182 |
| | 70 | 0.141 | 0.154 | 0.161 | 0.168 | 0.179 | 0.184 |
| | 71 | 0.143 | 0.156 | 0.164 | 0.170 | 0.182 | 0.186 |
| | 72 | 0.145 | 0.158 | 0.166 | 0.172 | 0.184 | 0.188 |
| | 73 | 0.147 | 0.160 | 0.168 | 0.174 | 0.186 | 0.191 |
| | 74 | 0.149 | 0.162 | 0.170 | 0.176 | 0.188 | 0.193 |
| | 75 | 0.151 | 0.165 | 0.172 | 0.178 | 0.190 | 0.195 |
| | 76 | 0.153 | 0.167 | 0.174 | 0.180 | 0.193 | 0.197 |
| | 77 | 0.155 | 0.169 | 0.176 | 0.183 | 0.195 | 0.199 |
| | 78 | 0.157 | 0.171 | 0.178 | 0.185 | 0.197 | 0.202 |
| | 79 | 0.159 | 0.173 | 0.180 | 0.187 | 0.199 | 0.204 |
| | 80 | 0.161 | 0.175 | 0.183 | 0.189 | 0.201 | 0.206 |
| | 81 | 0.163 | 0.177 | 0.185 | 0.191 | 0.204 | 0.208 |
| | 82 | 0.165 | 0.179 | 0.187 | 0.193 | 0.206 | 0.210 |
| | 83 | 0.167 | 0.181 | 0.189 | 0.195 | 0.208 | 0.213 |
| | 84 | 0.169 | 0.183 | 0.191 | 0.197 | 0.210 | 0.215 |
| | 85 | 0.171 | 0.185 | 0.193 | 0.200 | 0.212 | 0.217 |
| | 86 | 0.173 | 0.187 | 0.195 | 0.202 | 0.214 | 0.219 |
| | 87 | 0.175 | 0.189 | 0.197 | 0.204 | 0.217 | 0.221 |
| | 88 | 0.177 | 0.191 | 0.199 | 0.206 | 0.219 | 0.223 |
| | 89 | 0.179 | 0.193 | 0.201 | 0.208 | 0.221 | 0.226 |
| | 90 | 0.181 | 0.196 | 0.203 | 0.210 | 0.223 | 0.228 |
| | 91 | 0.183 | 0.198 | 0.206 | 0.212 | 0.225 | 0.230 |
| | 92 | 0.185 | 0.200 | 0.208 | 0.214 | 0.227 | 0.232 |
| | 93 | 0.187 | 0.202 | 0.210 | 0.216 | 0.229 | 0.234 |
| | 94 | 0.189 | 0.204 | 0.212 | 0.219 | 0.232 | 0.236 |
| | 95 | 0.191 | 0.206 | 0.214 | 0.221 | 0.234 | 0.239 |
| | 96 | 0.193 | 0.208 | 0.216 | 0.223 | 0.236 | 0.241 |
| | 97 | 0.195 | 0.210 | 0.218 | 0.225 | 0.238 | 0.243 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 550 | 0 | 0.001 | 0.002 | 0.004 | 0.005 | 0.008 | 0.009 |
| | 1 | 0.003 | 0.005 | 0.007 | 0.008 | 0.012 | 0.013 |
| | 2 | 0.004 | 0.007 | 0.009 | 0.011 | 0.015 | 0.016 |
| | 3 | 0.006 | 0.010 | 0.012 | 0.014 | 0.018 | 0.019 |
| | 4 | 0.008 | 0.012 | 0.014 | 0.016 | 0.020 | 0.022 |
| | 5 | 0.010 | 0.014 | 0.016 | 0.019 | 0.023 | 0.025 |
| | 6 | 0.012 | 0.016 | 0.019 | 0.021 | 0.026 | 0.028 |
| | 7 | 0.013 | 0.018 | 0.021 | 0.023 | 0.028 | 0.030 |
| | 8 | 0.015 | 0.020 | 0.023 | 0.026 | 0.031 | 0.033 |
| | 9 | 0.017 | 0.022 | 0.025 | 0.028 | 0.033 | 0.035 |
| | 10 | 0.019 | 0.024 | 0.027 | 0.030 | 0.036 | 0.038 |
| | 11 | 0.021 | 0.026 | 0.030 | 0.032 | 0.038 | 0.040 |
| | 12 | 0.023 | 0.028 | 0.032 | 0.035 | 0.041 | 0.043 |
| | 13 | 0.024 | 0.030 | 0.034 | 0.037 | 0.043 | 0.045 |
| | 14 | 0.026 | 0.032 | 0.036 | 0.039 | 0.045 | 0.048 |
| | 15 | 0.028 | 0.034 | 0.038 | 0.041 | 0.048 | 0.050 |
| | 16 | 0.030 | 0.036 | 0.040 | 0.043 | 0.050 | 0.052 |
| | 17 | 0.032 | 0.038 | 0.042 | 0.046 | 0.052 | 0.055 |
| | 18 | 0.033 | 0.040 | 0.044 | 0.048 | 0.054 | 0.057 |
| | 19 | 0.035 | 0.042 | 0.046 | 0.050 | 0.057 | 0.059 |
| | 20 | 0.037 | 0.044 | 0.048 | 0.052 | 0.059 | 0.062 |
| | 21 | 0.039 | 0.046 | 0.050 | 0.054 | 0.061 | 0.064 |
| | 22 | 0.041 | 0.048 | 0.052 | 0.056 | 0.063 | 0.066 |
| | 23 | 0.043 | 0.050 | 0.054 | 0.058 | 0.066 | 0.068 |
| | 24 | 0.044 | 0.052 | 0.057 | 0.060 | 0.068 | 0.071 |
| | 25 | 0.046 | 0.054 | 0.059 | 0.062 | 0.070 | 0.073 |
| | 26 | 0.048 | 0.056 | 0.061 | 0.064 | 0.072 | 0.075 |
| | 27 | 0.050 | 0.058 | 0.063 | 0.067 | 0.074 | 0.077 |
| | 28 | 0.052 | 0.060 | 0.065 | 0.069 | 0.077 | 0.080 |
| | 29 | 0.053 | 0.062 | 0.067 | 0.071 | 0.079 | 0.082 |
| | 30 | 0.055 | 0.064 | 0.069 | 0.073 | 0.081 | 0.084 |
| | 31 | 0.057 | 0.066 | 0.071 | 0.075 | 0.083 | 0.086 |
| | 32 | 0.059 | 0.068 | 0.073 | 0.077 | 0.085 | 0.088 |
| | 33 | 0.061 | 0.070 | 0.075 | 0.079 | 0.087 | 0.091 |
| | 34 | 0.062 | 0.072 | 0.077 | 0.081 | 0.089 | 0.093 |
| | 35 | 0.064 | 0.074 | 0.079 | 0.083 | 0.092 | 0.095 |
| | 36 | 0.066 | 0.075 | 0.081 | 0.085 | 0.094 | 0.097 |
| | 37 | 0.068 | 0.077 | 0.083 | 0.087 | 0.096 | 0.099 |
| | 38 | 0.070 | 0.079 | 0.085 | 0.089 | 0.098 | 0.101 |
| | 39 | 0.072 | 0.081 | 0.087 | 0.091 | 0.100 | 0.103 |
| | 40 | 0.073 | 0.083 | 0.089 | 0.093 | 0.102 | 0.106 |
| | 41 | 0.075 | 0.085 | 0.090 | 0.095 | 0.104 | 0.108 |
| | 42 | 0.077 | 0.087 | 0.092 | 0.097 | 0.106 | 0.110 |
| | 43 | 0.079 | 0.089 | 0.094 | 0.099 | 0.108 | 0.112 |
| | 44 | 0.081 | 0.091 | 0.096 | 0.101 | 0.110 | 0.114 |
| | 45 | 0.082 | 0.093 | 0.098 | 0.103 | 0.113 | 0.116 |
| | 46 | 0.084 | 0.095 | 0.100 | 0.105 | 0.115 | 0.118 |
| | 47 | 0.086 | 0.097 | 0.102 | 0.107 | 0.117 | 0.120 |
| | 48 | 0.088 | 0.098 | 0.104 | 0.109 | 0.119 | 0.122 |
| | 49 | 0.090 | 0.100 | 0.106 | 0.111 | 0.121 | 0.124 |
| | 50 | 0.092 | 0.102 | 0.108 | 0.113 | 0.123 | 0.127 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 550 | 51 | 0.093 | 0.104 | 0.110 | 0.115 | 0.125 | 0.129 |
| | 52 | 0.095 | 0.106 | 0.112 | 0.117 | 0.127 | 0.131 |
| | 53 | 0.097 | 0.108 | 0.114 | 0.119 | 0.129 | 0.133 |
| | 54 | 0.099 | 0.110 | 0.116 | 0.121 | 0.131 | 0.135 |
| | 55 | 0.101 | 0.112 | 0.118 | 0.123 | 0.133 | 0.137 |
| | 56 | 0.102 | 0.114 | 0.120 | 0.125 | 0.135 | 0.139 |
| | 57 | 0.104 | 0.116 | 0.122 | 0.127 | 0.137 | 0.141 |
| | 58 | 0.106 | 0.118 | 0.124 | 0.129 | 0.139 | 0.143 |
| | 59 | 0.108 | 0.119 | 0.126 | 0.131 | 0.141 | 0.145 |
| | 60 | 0.110 | 0.121 | 0.128 | 0.133 | 0.143 | 0.147 |
| | 61 | 0.112 | 0.123 | 0.130 | 0.135 | 0.145 | 0.149 |
| | 62 | 0.113 | 0.125 | 0.131 | 0.137 | 0.147 | 0.151 |
| | 63 | 0.115 | 0.127 | 0.133 | 0.139 | 0.149 | 0.153 |
| | 64 | 0.117 | 0.129 | 0.135 | 0.141 | 0.151 | 0.155 |
| | 65 | 0.119 | 0.131 | 0.137 | 0.143 | 0.153 | 0.157 |
| | 66 | 0.121 | 0.133 | 0.139 | 0.145 | 0.155 | 0.159 |
| | 67 | 0.122 | 0.135 | 0.141 | 0.147 | 0.157 | 0.161 |
| | 68 | 0.124 | 0.136 | 0.143 | 0.149 | 0.159 | 0.164 |
| | 69 | 0.126 | 0.138 | 0.145 | 0.151 | 0.161 | 0.166 |
| | 70 | 0.128 | 0.140 | 0.147 | 0.153 | 0.163 | 0.168 |
| | 71 | 0.130 | 0.142 | 0.149 | 0.155 | 0.165 | 0.170 |
| | 72 | 0.132 | 0.144 | 0.151 | 0.156 | 0.167 | 0.172 |
| | 73 | 0.133 | 0.146 | 0.153 | 0.158 | 0.169 | 0.174 |
| | 74 | 0.135 | 0.148 | 0.155 | 0.160 | 0.171 | 0.176 |
| | 75 | 0.137 | 0.150 | 0.157 | 0.162 | 0.173 | 0.178 |
| | 76 | 0.139 | 0.152 | 0.158 | 0.164 | 0.175 | 0.180 |
| | 77 | 0.141 | 0.153 | 0.160 | 0.166 | 0.177 | 0.182 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 600 | 0 | 0.001 | 0.002 | 0.003 | 0.004 | 0.007 | 0.008 |
| | 1 | 0.002 | 0.004 | 0.006 | 0.007 | 0.011 | 0.012 |
| | 2 | 0.004 | 0.007 | 0.008 | 0.010 | 0.013 | 0.015 |
| | 3 | 0.006 | 0.009 | 0.011 | 0.012 | 0.016 | 0.018 |
| | 4 | 0.007 | 0.011 | 0.013 | 0.015 | 0.019 | 0.020 |
| | 5 | 0.009 | 0.013 | 0.015 | 0.017 | 0.021 | 0.023 |
| | 6 | 0.011 | 0.015 | 0.017 | 0.019 | 0.024 | 0.025 |
| | 7 | 0.012 | 0.017 | 0.019 | 0.021 | 0.026 | 0.028 |
| | 8 | 0.014 | 0.018 | 0.021 | 0.023 | 0.028 | 0.030 |
| | 9 | 0.016 | 0.020 | 0.023 | 0.026 | 0.031 | 0.033 |
| | 10 | 0.017 | 0.022 | 0.025 | 0.028 | 0.033 | 0.035 |
| | 11 | 0.019 | 0.024 | 0.027 | 0.030 | 0.035 | 0.037 |
| | 12 | 0.021 | 0.026 | 0.029 | 0.032 | 0.037 | 0.039 |
| | 13 | 0.022 | 0.028 | 0.031 | 0.034 | 0.039 | 0.042 |
| | 14 | 0.024 | 0.030 | 0.033 | 0.036 | 0.042 | 0.044 |
| | 15 | 0.026 | 0.031 | 0.035 | 0.038 | 0.044 | 0.046 |
| | 16 | 0.027 | 0.033 | 0.037 | 0.040 | 0.046 | 0.048 |
| | 17 | 0.029 | 0.035 | 0.039 | 0.042 | 0.048 | 0.050 |
| | 18 | 0.031 | 0.037 | 0.041 | 0.044 | 0.050 | 0.052 |
| | 19 | 0.032 | 0.039 | 0.042 | 0.046 | 0.052 | 0.054 |
| | 20 | 0.034 | 0.041 | 0.044 | 0.048 | 0.054 | 0.057 |
| | 21 | 0.036 | 0.042 | 0.046 | 0.050 | 0.056 | 0.059 |
| | 22 | 0.037 | 0.044 | 0.048 | 0.051 | 0.058 | 0.061 |
| | 23 | 0.039 | 0.046 | 0.050 | 0.053 | 0.060 | 0.063 |
| | 24 | 0.041 | 0.048 | 0.052 | 0.055 | 0.062 | 0.065 |
| | 25 | 0.042 | 0.050 | 0.054 | 0.057 | 0.064 | 0.067 |
| | 26 | 0.044 | 0.051 | 0.056 | 0.059 | 0.066 | 0.069 |
| | 27 | 0.046 | 0.053 | 0.057 | 0.061 | 0.068 | 0.071 |
| | 28 | 0.047 | 0.055 | 0.059 | 0.063 | 0.070 | 0.073 |
| | 29 | 0.049 | 0.057 | 0.061 | 0.065 | 0.072 | 0.075 |
| | 30 | 0.051 | 0.058 | 0.063 | 0.067 | 0.074 | 0.077 |
| | 31 | 0.052 | 0.060 | 0.065 | 0.069 | 0.076 | 0.079 |
| | 32 | 0.054 | 0.062 | 0.067 | 0.070 | 0.078 | 0.081 |
| | 33 | 0.056 | 0.064 | 0.068 | 0.072 | 0.080 | 0.083 |
| | 34 | 0.057 | 0.066 | 0.070 | 0.074 | 0.082 | 0.085 |
| | 35 | 0.059 | 0.067 | 0.072 | 0.076 | 0.084 | 0.087 |
| | 36 | 0.061 | 0.069 | 0.074 | 0.078 | 0.086 | 0.089 |
| | 37 | 0.062 | 0.071 | 0.076 | 0.080 | 0.088 | 0.091 |
| | 38 | 0.064 | 0.073 | 0.078 | 0.082 | 0.090 | 0.093 |
| | 39 | 0.066 | 0.074 | 0.079 | 0.084 | 0.092 | 0.095 |
| | 40 | 0.067 | 0.076 | 0.081 | 0.085 | 0.094 | 0.097 |
| | 41 | 0.069 | 0.078 | 0.083 | 0.087 | 0.096 | 0.099 |
| | 42 | 0.071 | 0.080 | 0.085 | 0.089 | 0.098 | 0.101 |
| | 43 | 0.072 | 0.081 | 0.087 | 0.091 | 0.099 | 0.103 |
| | 44 | 0.074 | 0.083 | 0.088 | 0.093 | 0.101 | 0.105 |
| | 45 | 0.076 | 0.085 | 0.090 | 0.095 | 0.103 | 0.107 |
| | 46 | 0.077 | 0.087 | 0.092 | 0.096 | 0.105 | 0.108 |
| | 47 | 0.079 | 0.089 | 0.094 | 0.098 | 0.107 | 0.110 |
| | 48 | 0.081 | 0.090 | 0.096 | 0.100 | 0.109 | 0.112 |
| | 49 | 0.082 | 0.092 | 0.097 | 0.102 | 0.111 | 0.114 |
| | 50 | 0.084 | 0.094 | 0.099 | 0.104 | 0.113 | 0.116 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 600 | 51 | 0.086 | 0.096 | 0.101 | 0.106 | 0.115 | 0.118 |
| | 52 | 0.087 | 0.097 | 0.103 | 0.107 | 0.117 | 0.120 |
| | 53 | 0.089 | 0.099 | 0.105 | 0.109 | 0.118 | 0.122 |
| | 54 | 0.091 | 0.101 | 0.106 | 0.111 | 0.120 | 0.124 |
| | 55 | 0.092 | 0.103 | 0.108 | 0.113 | 0.122 | 0.126 |
| | 56 | 0.094 | 0.104 | C.110 | 0.115 | 0.124 | 0.128 |
| | 57 | 0.096 | 0.106 | 0.112 | 0.117 | 0.126 | 0.129 |
| | 58 | 0.097 | 0.108 | 0.113 | 0.118 | 0.128 | 0.131 |
| | 59 | 0.099 | 0.109 | 0.115 | 0.120 | 0.130 | 0.133 |
| | 60 | 0.101 | 0.111 | 0.117 | 0.122 | 0.132 | 0.135 |
| | 61 | 0.102 | 0.113 | 0.119 | 0.124 | 0.133 | 0.137 |
| | 62 | 0.104 | 0.115 | 0.121 | 0.126 | 0.135 | 0.139 |
| | 63 | 0.106 | 0.116 | 0.122 | 0.127 | 0.137 | 0.141 |
| | 64 | 0.107 | 0.118 | 0.124 | 0.129 | 0.139 | 0.143 |
| | 65 | 0.109 | 0.120 | 0.126 | 0.131 | 0.141 | 0.145 |
| | 66 | 0.111 | 0.122 | 0.128 | 0.133 | 0.143 | 0.146 |
| | 67 | 0.112 | 0.123 | 0.129 | 0.135 | 0.145 | 0.148 |
| | 68 | 0.114 | 0.125 | 0.131 | 0.136 | 0.146 | 0.150 |
| | 69 | 0.116 | 0.127 | 0.133 | 0.138 | 0.148 | 0.152 |
| | 70 | 0.117 | 0.129 | 0.135 | 0.140 | 0.150 | 0.154 |
| | 71 | 0.119 | 0.130 | 0.137 | 0.142 | 0.152 | 0.156 |
| | 72 | 0.121 | 0.132 | 0.138 | 0.144 | 0.154 | 0.158 |
| | 73 | 0.122 | 0.134 | 0.140 | 0.145 | 0.156 | 0.159 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 650 | 0 | 0.001 | 0.002 | 0.003 | 0.004 | 0.007 | 0.008 |
| | 1 | 0.002 | 0.004 | 0.005 | 0.007 | 0.010 | 0.011 |
| | 2 | 0.004 | 0.006 | 0.008 | 0.009 | 0.012 | 0.014 |
| | 3 | 0.005 | 0.008 | 0.010 | 0.011 | 0.015 | 0.016 |
| | 4 | 0.007 | 0.010 | 0.012 | 0.014 | 0.017 | 0.019 |
| | 5 | 0.008 | 0.012 | 0.014 | 0.016 | 0.020 | 0.021 |
| | 6 | 0.010 | 0.013 | 0.016 | 0.018 | 0.022 | 0.023 |
| | 7 | 0.011 | 0.015 | 0.018 | 0.020 | 0.024 | 0.026 |
| | 8 | 0.013 | 0.017 | 0.019 | 0.022 | 0.026 | 0.028 |
| | 9 | 0.014 | 0.019 | 0.021 | 0.024 | 0.028 | 0.030 |
| | 10 | 0.016 | 0.020 | 0.023 | 0.025 | 0.030 | 0.032 |
| | 11 | 0.017 | 0.022 | 0.025 | 0.027 | 0.032 | 0.034 |
| | 12 | 0.019 | 0.024 | 0.027 | 0.029 | 0.034 | 0.036 |
| | 13 | 0.021 | 0.026 | 0.029 | 0.031 | 0.036 | 0.038 |
| | 14 | 0.022 | 0.027 | 0.030 | 0.033 | 0.038 | 0.040 |
| | 15 | 0.024 | 0.029 | 0.032 | 0.035 | 0.040 | 0.042 |
| | 16 | 0.025 | 0.031 | 0.034 | 0.037 | 0.042 | 0.044 |
| | 17 | 0.027 | 0.032 | 0.036 | 0.038 | 0.044 | 0.046 |
| | 18 | 0.028 | 0.034 | 0.037 | 0.040 | 0.046 | 0.048 |
| | 19 | 0.030 | 0.036 | 0.039 | 0.042 | 0.048 | 0.050 |
| | 20 | 0.031 | 0.037 | 0.041 | 0.044 | 0.050 | 0.052 |
| | 21 | 0.033 | 0.039 | 0.043 | 0.046 | 0.052 | 0.054 |
| | 22 | 0.034 | 0.041 | 0.044 | 0.047 | 0.054 | 0.056 |
| | 23 | 0.036 | 0.042 | 0.046 | 0.049 | 0.056 | 0.058 |
| | 24 | 0.037 | 0.044 | 0.048 | 0.051 | 0.057 | 0.060 |
| | 25 | 0.039 | 0.046 | 0.050 | 0.053 | 0.059 | 0.062 |
| | 26 | 0.041 | 0.047 | 0.051 | 0.055 | 0.061 | 0.064 |
| | 27 | 0.042 | 0.049 | 0.053 | 0.056 | 0.063 | 0.066 |
| | 28 | 0.044 | 0.051 | 0.055 | 0.058 | 0.065 | 0.067 |
| | 29 | 0.045 | 0.052 | 0.056 | 0.060 | 0.067 | 0.069 |
| | 30 | 0.047 | 0.054 | 0.058 | 0.062 | 0.069 | 0.071 |
| | 31 | 0.048 | 0.056 | 0.060 | 0.063 | 0.070 | 0.073 |
| | 32 | 0.050 | 0.057 | 0.061 | 0.065 | 0.072 | 0.075 |
| | 33 | 0.051 | 0.059 | 0.063 | 0.067 | 0.074 | 0.077 |
| | 34 | 0.053 | 0.061 | 0.065 | 0.069 | 0.076 | 0.079 |
| | 35 | 0.054 | 0.062 | 0.067 | 0.070 | 0.078 | 0.080 |
| | 36 | 0.056 | 0.064 | 0.068 | 0.072 | 0.079 | 0.082 |
| | 37 | 0.057 | 0.065 | 0.070 | 0.074 | 0.081 | 0.084 |
| | 38 | 0.059 | 0.067 | 0.072 | 0.075 | 0.083 | 0.086 |
| | 39 | 0.060 | 0.069 | 0.073 | 0.077 | 0.085 | 0.088 |
| | 40 | 0.062 | 0.070 | 0.075 | 0.079 | 0.087 | 0.089 |
| | 41 | 0.064 | 0.072 | 0.077 | 0.081 | 0.088 | 0.091 |
| | 42 | 0.065 | 0.074 | 0.078 | 0.082 | 0.090 | 0.093 |
| | 43 | 0.067 | 0.075 | 0.080 | 0.084 | 0.092 | 0.095 |
| | 44 | 0.068 | 0.077 | 0.082 | 0.086 | 0.094 | 0.097 |
| | 45 | 0.070 | 0.078 | 0.083 | 0.087 | 0.095 | 0.098 |
| | 46 | 0.071 | 0.080 | 0.085 | 0.089 | 0.097 | 0.100 |
| | 47 | 0.073 | 0.082 | 0.087 | 0.091 | 0.099 | 0.102 |
| | 48 | 0.074 | 0.083 | 0.088 | 0.092 | 0.101 | 0.104 |
| | 49 | 0.076 | 0.085 | 0.090 | 0.094 | 0.102 | 0.106 |
| | 50 | 0.077 | 0.087 | 0.092 | 0.096 | 0.104 | 0.107 |

Appendix 3B

Table 3B

| N | F | C = .500 | .800 | .900 | .950 | 1990 | .995 |
|---|---|---|---|---|---|---|---|
| 650 | 51 | 0.079 | 0.088 | 0.093 | 0.098 | 0.106 | 0.109 |
| | 52 | 0.080 | 0.090 | 0.095 | 0.099 | 0.108 | 0.111 |
| | 53 | 0.082 | 0.091 | 0.097 | 0.101 | 0.109 | 0.113 |
| | 54 | 0.084 | 0.093 | 0.098 | 0.103 | 0.111 | 0.114 |
| | 55 | 0.085 | 0.095 | 0.100 | 0.104 | 0.113 | 0.116 |
| | 56 | 0.087 | 0.096 | 0.102 | 0.106 | 0.115 | 0.118 |
| | 57 | 0.088 | 0.098 | 0.103 | 0.108 | 0.116 | 0.120 |
| | 58 | 0.090 | 0.099 | 0.105 | 0.109 | 0.118 | 0.121 |
| | 59 | 0.091 | 0.101 | 0.106 | 0.111 | 0.120 | 0.123 |
| | 60 | 0.093 | 0.103 | 0.108 | 0.113 | 0.122 | 0.125 |
| | 61 | 0.094 | 0.104 | 0.110 | 0.114 | 0.123 | 0.127 |
| | 62 | 0.096 | 0.106 | 0.111 | 0.116 | 0.125 | 0.128 |
| | 63 | 0.097 | 0.107 | 0.113 | 0.118 | 0.127 | 0.130 |
| | 64 | 0.099 | 0.109 | 0.115 | 0.119 | 0.128 | 0.132 |
| | 65 | 0.100 | 0.111 | 0.116 | 0.121 | 0.130 | 0.134 |
| | 66 | 0.102 | 0.112 | 0.118 | 0.123 | 0.132 | 0.135 |
| | 67 | 0.104 | 0.114 | 0.120 | 0.124 | 0.134 | 0.137 |
| | 68 | 0.105 | 0.116 | 0.121 | 0.126 | 0.135 | 0.139 |
| | 69 | 0.107 | 0.117 | 0.123 | 0.128 | 0.137 | 0.140 |
| | 70 | 0.108 | 0.119 | 0.124 | 0.129 | 0.139 | 0.142 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 700 | 0 | 0.000 | 0.002 | 0.003 | 0.004 | 0.006 | 0.007 |
| | 1 | 0.002 | 0.004 | 0.005 | 0.006 | 0.009 | 0.010 |
| | 2 | 0.003 | 0.006 | 0.007 | 0.008 | 0.011 | 0.013 |
| | 3 | 0.005 | 0.007 | 0.009 | 0.011 | 0.014 | 0.015 |
| | 4 | 0.006 | 0.009 | 0.011 | 0.013 | 0.016 | 0.017 |
| | 5 | 0.008 | 0.011 | 0.013 | 0.014 | 0.018 | 0.020 |
| | 6 | 0.009 | 0.012 | 0.014 | 0.016 | 0.020 | 0.022 |
| | 7 | 0.010 | 0.014 | 0.016 | 0.018 | 0.022 | 0.024 |
| | 8 | 0.012 | 0.016 | 0.018 | 0.020 | 0.024 | 0.026 |
| | 9 | 0.013 | 0.017 | 0.020 | 0.022 | 0.026 | 0.028 |
| | 10 | 0.015 | 0.019 | 0.021 | 0.024 | 0.028 | 0.030 |
| | 11 | 0.016 | 0.021 | 0.023 | 0.025 | 0.030 | 0.032 |
| | 12 | 0.018 | 0.022 | 0.025 | 0.027 | 0.032 | 0.034 |
| | 13 | 0.019 | 0.024 | 0.026 | 0.029 | 0.034 | 0.036 |
| | 14 | 0.020 | 0.025 | 0.028 | 0.031 | 0.036 | 0.037 |
| | 15 | 0.022 | 0.027 | 0.030 | 0.032 | 0.037 | 0.039 |
| | 16 | 0.023 | 0.028 | 0.031 | 0.034 | 0.039 | 0.041 |
| | 17 | 0.025 | 0.030 | 0.033 | 0.036 | 0.041 | 0.043 |
| | 18 | 0.026 | 0.032 | 0.035 | 0.037 | 0.043 | 0.045 |
| | 19 | 0.028 | 0.033 | 0.036 | 0.039 | 0.045 | 0.047 |
| | 20 | 0.029 | 0.035 | 0.038 | 0.041 | 0.046 | 0.049 |
| | 21 | 0.030 | 0.036 | 0.040 | 0.042 | 0.048 | 0.050 |
| | 22 | 0.032 | 0.038 | 0.041 | 0.044 | 0.050 | 0.052 |
| | 23 | 0.033 | 0.039 | 0.043 | 0.046 | 0.052 | 0.054 |
| | 24 | 0.035 | 0.041 | 0.044 | 0.047 | 0.053 | 0.056 |
| | 25 | 0.036 | 0.042 | 0.046 | 0.049 | 0.055 | 0.057 |
| | 26 | 0.038 | 0.044 | 0.048 | 0.051 | 0.057 | 0.059 |
| | 27 | 0.039 | 0.046 | 0.049 | 0.052 | 0.059 | 0.061 |
| | 28 | 0.040 | 0.047 | 0.051 | 0.054 | 0.060 | 0.063 |
| | 29 | 0.042 | 0.049 | 0.052 | 0.056 | 0.062 | 0.064 |
| | 30 | 0.043 | 0.050 | 0.054 | 0.057 | 0.064 | 0.066 |
| | 31 | 0.045 | 0.052 | 0.055 | 0.059 | 0.065 | 0.068 |
| | 32 | 0.046 | 0.053 | 0.057 | 0.060 | 0.067 | 0.070 |
| | 33 | 0.048 | 0.055 | 0.059 | 0.062 | 0.069 | 0.071 |
| | 34 | 0.049 | 0.056 | 0.060 | 0.064 | 0.070 | 0.073 |
| | 35 | 0.050 | 0.058 | 0.062 | 0.065 | 0.072 | 0.075 |
| | 36 | 0.052 | 0.059 | 0.063 | 0.067 | 0.074 | 0.076 |
| | 37 | 0.053 | 0.061 | 0.065 | 0.068 | 0.075 | 0.078 |
| | 38 | 0.055 | 0.062 | 0.066 | 0.070 | 0.077 | 0.080 |
| | 39 | 0.056 | 0.064 | 0.068 | 0.072 | 0.079 | 0.081 |
| | 40 | 0.058 | 0.065 | 0.070 | 0.073 | 0.080 | 0.083 |
| | 41 | 0.059 | 0.067 | 0.071 | 0.075 | 0.082 | 0.085 |
| | 42 | 0.060 | 0.068 | 0.073 | 0.076 | 0.084 | 0.086 |
| | 43 | 0.062 | 0.070 | 0.074 | 0.078 | 0.085 | 0.088 |
| | 44 | 0.063 | 0.071 | 0.076 | 0.080 | 0.087 | 0.090 |
| | 45 | 0.065 | 0.073 | 0.077 | 0.081 | 0.089 | 0.091 |
| | 46 | 0.066 | 0.074 | 0.079 | 0.083 | 0.090 | 0.093 |
| | 47 | 0.068 | 0.076 | 0.080 | 0.084 | 0.092 | 0.095 |
| | 48 | 0.069 | 0.077 | 0.082 | 0.086 | 0.094 | 0.096 |
| | 49 | 0.070 | 0.079 | 0.084 | 0.087 | 0.095 | 0.098 |
| | 50 | 0.072 | 0.080 | 0.085 | 0.089 | 0.097 | 0.100 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 700 | 51 | 0.073 | 0.082 | 0.087 | 0.091 | 0.098 | 0.101 |
| | 52 | 0.075 | 0.083 | 0.088 | 0.092 | 0.100 | 0.103 |
| | 53 | 0.076 | 0.085 | 0.090 | 0.094 | 0.102 | 0.105 |
| | 54 | 0.078 | 0.086 | 0.091 | 0.095 | 0.103 | 0.106 |
| | 55 | 0.079 | 0.088 | 0.093 | 0.097 | 0.105 | 0.108 |
| | 56 | 0.080 | 0.089 | 0.094 | 0.098 | 0.107 | 0.110 |
| | 57 | 0.082 | 0.091 | 0.096 | 0.100 | 0.108 | 0.111 |
| | 58 | 0.083 | 0.092 | 0.097 | 0.102 | 0.110 | 0.113 |
| | 59 | 0.085 | 0.094 | 0.099 | 0.103 | 0.111 | 0.114 |
| | 60 | 0.086 | 0.095 | 0.100 | 0.105 | 0.113 | 0.116 |
| | 61 | 0.088 | 0.097 | 0.102 | 0.106 | 0.115 | 0.118 |
| | 62 | 0.089 | 0.098 | 0.103 | 0.108 | 0.116 | 0.119 |
| | 63 | 0.090 | 0.100 | 0.105 | 0.109 | 0.118 | 0.121 |
| | 64 | 0.092 | 0.101 | 0.106 | 0.111 | 0.119 | 0.123 |
| | 65 | 0.093 | 0.103 | 0.108 | 0.112 | 0.121 | 0.124 |
| | 66 | 0.095 | 0.104 | 0.110 | 0.114 | 0.123 | 0.126 |
| | 67 | 0.096 | 0.106 | 0.111 | 0.116 | 0.124 | 0.127 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 750 | 0 | 0.000 | 0.002 | 0.003 | 0.003 | 0.006 | 0.007 |
| | 1 | 0.002 | 0.003 | 0.005 | 0.006 | 0.008 | 0.009 |
| | 2 | 0.003 | 0.005 | 0.007 | 0.008 | 0.011 | 0.012 |
| | 3 | 0.004 | 0.007 | 0.008 | 0.010 | 0.013 | 0.014 |
| | 4 | 0.006 | 0.008 | 0.010 | 0.012 | 0.015 | 0.016 |
| | 5 | 0.007 | 0.010 | 0.012 | 0.013 | 0.017 | 0.018 |
| | 6 | 0.008 | 0.012 | 0.014 | 0.015 | 0.019 | 0.020 |
| | 7 | 0.010 | 0.013 | 0.015 | 0.017 | 0.021 | 0.022 |
| | 8 | 0.011 | 0.015 | 0.017 | 0.019 | 0.023 | 0.024 |
| | 9 | 0.012 | 0.016 | 0.018 | 0.020 | 0.024 | 0.026 |
| | 10 | 0.014 | 0.018 | 0.020 | 0.022 | 0.026 | 0.028 |
| | 11 | 0.015 | 0.019 | 0.022 | 0.024 | 0.028 | 0.030 |
| | 12 | 0.016 | 0.021 | 0.023 | 0.025 | 0.030 | 0.031 |
| | 13 | 0.018 | 0.022 | 0.025 | 0.027 | 0.031 | 0.033 |
| | 14 | 0.019 | 0.024 | 0.026 | 0.029 | 0.033 | 0.035 |
| | 15 | 0.020 | 0.025 | 0.028 | 0.030 | 0.035 | 0.037 |
| | 16 | 0.022 | 0.027 | 0.029 | 0.032 | 0.037 | 0.038 |
| | 17 | 0.023 | 0.028 | 0.031 | 0.033 | 0.038 | 0.040 |
| | 18 | 0.024 | 0.029 | 0.032 | 0.035 | 0.040 | 0.042 |
| | 19 | 0.026 | 0.031 | 0.034 | 0.036 | 0.042 | 0.044 |
| | 20 | 0.027 | 0.032 | 0.035 | 0.038 | 0.043 | 0.045 |
| | 21 | 0.028 | 0.034 | 0.037 | 0.040 | 0.045 | 0.047 |
| | 22 | 0.030 | 0.035 | 0.038 | 0.041 | 0.047 | 0.049 |
| | 23 | 0.031 | 0.037 | 0.040 | 0.043 | 0.048 | 0.050 |
| | 24 | 0.032 | 0.038 | 0.041 | 0.044 | 0.050 | 0.052 |
| | 25 | 0.034 | 0.040 | 0.043 | 0.046 | 0.051 | 0.054 |
| | 26 | 0.035 | 0.041 | 0.044 | 0.047 | 0.053 | 0.055 |
| | 27 | 0.036 | 0.042 | 0.046 | 0.049 | 0.055 | 0.057 |
| | 28 | 0.038 | 0.044 | 0.047 | 0.050 | 0.056 | 0.058 |
| | 29 | 0.039 | 0.045 | 0.049 | 0.052 | 0.058 | 0.060 |
| | 30 | 0.040 | 0.047 | 0.050 | 0.053 | 0.059 | 0.062 |
| | 31 | 0.042 | 0.048 | 0.052 | 0.055 | 0.061 | 0.063 |
| | 32 | 0.043 | 0.050 | 0.053 | 0.056 | 0.063 | 0.065 |
| | 33 | 0.044 | 0.051 | 0.055 | 0.058 | 0.064 | 0.067 |
| | 34 | 0.046 | 0.052 | 0.056 | 0.059 | 0.066 | 0.068 |
| | 35 | 0.047 | 0.054 | 0.058 | 0.061 | 0.067 | 0.070 |
| | 36 | 0.048 | 0.055 | 0.059 | 0.062 | 0.069 | 0.071 |
| | 37 | 0.050 | 0.057 | 0.061 | 0.064 | 0.070 | 0.073 |
| | 38 | 0.051 | 0.058 | 0.062 | 0.065 | 0.072 | 0.074 |
| | 39 | 0.052 | 0.060 | 0.063 | 0.067 | 0.074 | 0.076 |
| | 40 | 0.054 | 0.061 | 0.065 | 0.068 | 0.075 | 0.078 |
| | 41 | 0.055 | 0.062 | 0.066 | 0.070 | 0.077 | 0.079 |
| | 42 | 0.056 | 0.064 | 0.068 | 0.071 | 0.078 | 0.081 |
| | 43 | 0.058 | 0.065 | 0.069 | 0.073 | 0.080 | 0.082 |
| | 44 | 0.059 | 0.067 | 0.071 | 0.074 | 0.081 | 0.084 |
| | 45 | 0.060 | 0.068 | 0.072 | 0.076 | 0.083 | 0.085 |
| | 46 | 0.062 | 0.069 | 0.074 | 0.077 | 0.084 | 0.087 |
| | 47 | 0.063 | 0.071 | 0.075 | 0.079 | 0.086 | 0.089 |
| | 48 | 0.064 | 0.072 | 0.077 | 0.080 | 0.087 | 0.090 |
| | 49 | 0.066 | 0.074 | 0.078 | 0.082 | 0.089 | 0.092 |
| | 50 | 0.067 | 0.075 | 0.079 | 0.083 | 0.090 | 0.093 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 750 | 51 | 0.068 | 0.076 | 0.081 | 0.085 | 0.092 | 0.095 |
| | 52 | 0.070 | 0.078 | 0.082 | 0.086 | 0.093 | 0.096 |
| | 53 | 0.071 | 0.079 | 0.084 | 0.088 | 0.095 | 0.098 |
| | 54 | 0.072 | 0.081 | 0.085 | 0.089 | 0.096 | 0.099 |
| | 55 | 0.074 | 0.082 | 0.087 | 0.090 | 0.098 | 0.101 |
| | 56 | 0.075 | 0.083 | 0.088 | 0.092 | 0.099 | 0.102 |
| | 57 | 0.076 | 0.085 | 0.089 | 0.093 | 0.101 | 0.104 |
| | 58 | 0.078 | 0.086 | 0.091 | 0.095 | 0.103 | 0.105 |
| | 59 | 0.079 | 0.088 | 0.092 | 0.096 | 0.104 | 0.107 |
| | 60 | 0.080 | 0.089 | 0.094 | 0.098 | 0.106 | 0.108 |
| | 61 | 0.082 | 0.090 | 0.095 | 0.099 | 0.107 | 0.110 |
| | 62 | 0.083 | 0.092 | 0.097 | 0.101 | 0.109 | 0.111 |
| | 63 | 0.084 | 0.093 | 0.098 | 0.102 | 0.110 | 0.113 |
| | 64 | 0.086 | 0.095 | 0.099 | 0.104 | 0.111 | 0.114 |
| | 65 | 0.087 | 0.096 | 0.101 | 0.105 | 0.113 | 0.116 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 800 | 0 | 0.000 | 0.002 | 0.002 | 0.003 | 0.005 | 0.006 |
| | 1 | 0.002 | 0.003 | 0.004 | 0.005 | 0.008 | 0.009 |
| | 2 | 0.003 | 0.005 | 0.006 | 0.007 | 0.010 | 0.011 |
| | 3 | 0.004 | 0.006 | 0.008 | 0.009 | 0.012 | 0.013 |
| | 4 | 0.005 | 0.008 | 0.009 | 0.011 | 0.014 | 0.015 |
| | 5 | 0.007 | 0.009 | 0.011 | 0.013 | 0.016 | 0.017 |
| | 6 | 0.008 | 0.011 | 0.013 | 0.014 | 0.018 | 0.019 |
| | 7 | 0.009 | 0.012 | 0.014 | 0.016 | 0.019 | 0.021 |
| | 8 | 0.010 | 0.014 | 0.016 | 0.017 | 0.021 | 0.023 |
| | 9 | 0.012 | 0.015 | 0.017 | 0.019 | 0.023 | 0.024 |
| | 10 | 0.013 | 0.017 | 0.019 | 0.021 | 0.025 | 0.026 |
| | 11 | 0.014 | 0.018 | 0.020 | 0.022 | 0.026 | 0.028 |
| | 12 | 0.015 | 0.019 | 0.022 | 0.024 | 0.028 | 0.029 |
| | 13 | 0.017 | 0.021 | 0.023 | 0.025 | 0.029 | 0.031 |
| | 14 | 0.018 | 0.022 | 0.025 | 0.027 | 0.031 | 0.033 |
| | 15 | 0.019 | 0.023 | 0.026 | 0.028 | 0.033 | 0.034 |
| | 16 | 0.020 | 0.025 | 0.027 | 0.030 | 0.034 | 0.036 |
| | 17 | 0.022 | 0.026 | 0.029 | 0.031 | 0.036 | 0.038 |
| | 18 | 0.023 | 0.028 | 0.030 | 0.033 | 0.037 | 0.039 |
| | 19 | 0.024 | 0.029 | 0.032 | 0.034 | 0.039 | 0.041 |
| | 20 | 0.025 | 0.030 | 0.033 | 0.036 | 0.041 | 0.042 |
| | 21 | 0.027 | 0.032 | 0.035 | 0.037 | 0.042 | 0.044 |
| | 22 | 0.028 | 0.033 | 0.036 | 0.039 | 0.044 | 0.046 |
| | 23 | 0.029 | 0.034 | 0.037 | 0.040 | 0.045 | 0.047 |
| | 24 | 0.030 | 0.036 | 0.039 | 0.041 | 0.047 | 0.049 |
| | 25 | 0.032 | 0.037 | 0.040 | 0.043 | 0.048 | 0.050 |
| | 26 | 0.033 | 0.038 | 0.042 | 0.044 | 0.050 | 0.052 |
| | 27 | 0.034 | 0.040 | 0.043 | 0.046 | 0.051 | 0.053 |
| | 28 | 0.035 | 0.041 | 0.044 | 0.047 | 0.053 | 0.055 |
| | 29 | 0.037 | 0.042 | 0.046 | 0.049 | 0.054 | 0.056 |
| | 30 | 0.038 | 0.044 | 0.047 | 0.050 | 0.056 | 0.058 |
| | 31 | 0.039 | 0.045 | 0.049 | 0.051 | 0.057 | 0.059 |
| | 32 | 0.040 | 0.046 | 0.050 | 0.053 | 0.059 | 0.061 |
| | 33 | 0.042 | 0.048 | 0.051 | 0.054 | 0.060 | 0.062 |
| | 34 | 0.043 | 0.049 | 0.053 | 0.056 | 0.062 | 0.064 |
| | 35 | 0.044 | 0.050 | 0.054 | 0.057 | 0.063 | 0.065 |
| | 36 | 0.045 | 0.052 | 0.055 | 0.058 | 0.065 | 0.067 |
| | 37 | 0.047 | 0.053 | 0.057 | 0.060 | 0.066 | 0.068 |
| | 38 | 0.048 | 0.054 | 0.058 | 0.061 | 0.067 | 0.070 |
| | 39 | 0.049 | 0.056 | 0.060 | 0.063 | 0.069 | 0.071 |
| | 40 | 0.050 | 0.057 | 0.061 | 0.064 | 0.070 | 0.073 |
| | 41 | 0.052 | 0.058 | 0.062 | 0.065 | 0.072 | 0.074 |
| | 42 | 0.053 | 0.060 | 0.064 | 0.067 | 0.073 | 0.076 |
| | 43 | 0.054 | 0.061 | 0.065 | 0.068 | 0.075 | 0.077 |
| | 44 | 0.055 | 0.062 | 0.066 | 0.070 | 0.076 | 0.079 |
| | 45 | 0.057 | 0.064 | 0.068 | 0.071 | 0.078 | 0.080 |
| | 46 | 0.058 | 0.065 | 0.069 | 0.072 | 0.079 | 0.082 |
| | 47 | 0.059 | 0.066 | 0.070 | 0.074 | 0.081 | 0.083 |
| | 48 | 0.060 | 0.068 | 0.072 | 0.075 | 0.082 | 0.084 |
| | 49 | 0.062 | 0.069 | 0.073 | 0.077 | 0.083 | 0.086 |
| | 50 | 0.063 | 0.070 | 0.074 | 0.078 | 0.085 | 0.087 |

Appendix 3B
Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 800 | 51 | 0.064 | 0.072 | 0.076 | 0.079 | 0.086 | 0.089 |
| | 52 | 0.065 | 0.073 | 0.077 | 0.081 | 0.088 | 0.090 |
| | 53 | 0.067 | 0.074 | 0.078 | 0.082 | 0.089 | 0.092 |
| | 54 | 0.068 | 0.076 | 0.080 | 0.083 | 0.090 | 0.093 |
| | 55 | 0.069 | 0.077 | 0.081 | 0.085 | 0.092 | 0.095 |
| | 56 | 0.070 | 0.078 | 0.083 | 0.086 | 0.093 | 0.096 |
| | 57 | 0.072 | 0.079 | 0.084 | 0.088 | 0.095 | 0.097 |
| | 58 | 0.073 | 0.081 | 0.085 | 0.089 | 0.096 | 0.099 |
| | 59 | 0.074 | 0.082 | 0.087 | 0.090 | 0.098 | 0.100 |
| | 60 | 0.075 | 0.083 | 0.088 | 0.092 | 0.099 | 0.102 |
| | 61 | 0.077 | 0.085 | 0.089 | 0.093 | 0.100 | 0.103 |
| | 62 | 0.078 | 0.086 | 0.091 | 0.094 | 0.102 | 0.105 |
| | 63 | 0.079 | 0.087 | 0.092 | 0.096 | 0.103 | 0.106 |

**Table I (continued)**

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 850 | 0 | 0.000 | 0.001 | 0.002 | 0.003 | 0.005 | 0.006 |
| | 1 | 0.001 | 0.003 | 0.004 | 0.005 | 0.007 | 0.008 |
| | 2 | 0.003 | 0.005 | 0.006 | 0.007 | 0.009 | 0.010 |
| | 3 | 0.004 | 0.006 | 0.007 | 0.009 | 0.011 | 0.012 |
| | 4 | 0.005 | 0.007 | 0.009 | 0.010 | 0.013 | 0.014 |
| | 5 | 0.006 | 0.009 | 0.010 | 0.012 | 0.015 | 0.016 |
| | 6 | 0.007 | 0.010 | 0.012 | 0.013 | 0.017 | 0.018 |
| | 7 | 0.009 | 0.012 | 0.013 | 0.015 | 0.018 | 0.020 |
| | 8 | 0.101 | 0.013 | 0.015 | 0.016 | 0.020 | 0.021 |
| | 9 | 0.011 | 0.014 | 0.016 | 0.018 | 0.021 | 0.023 |
| | 10 | 0.012 | 0.016 | 0.018 | 0.019 | 0.023 | 0.025 |
| | 11 | 0.013 | 0.017 | 0.019 | 0.021 | 0.025 | 0.026 |
| | 12 | 0.014 | 0.018 | 0.020 | 0.022 | 0.026 | 0.028 |
| | 13 | 0.016 | 0.019 | 0.022 | 0.024 | 0.028 | 0.029 |
| | 14 | 0.017 | 0.021 | 0.023 | 0.025 | 0.029 | 0.031 |
| | 15 | 0.018 | 0.022 | 0.024 | 0.027 | 0.031 | 0.032 |
| | 16 | 0.019 | 0.023 | 0.026 | 0.028 | 0.032 | 0.034 |
| | 17 | 0.020 | 0.025 | 0.027 | 0.029 | 0.034 | 0.035 |
| | 18 | 0.021 | 0.026 | 0.029 | 0.031 | 0.035 | 0.037 |
| | 19 | 0.023 | 0.027 | 0.030 | 0.032 | 0.037 | 0.038 |
| | 20 | 0.024 | 0.029 | 0.031 | 0.034 | 0.038 | 0.040 |
| | 21 | 0.025 | 0.030 | 0.033 | 0.035 | 0.040 | 0.041 |
| | 22 | 0.026 | 0.031 | 0.034 | 0.036 | 0.041 | 0.043 |
| | 23 | 0.027 | 0.032 | 0.035 | 0.038 | 0.042 | 0.044 |
| | 24 | 0.029 | 0.034 | 0.036 | 0.039 | 0.044 | 0.046 |
| | 25 | 0.030 | 0.035 | 0.038 | 0.040 | 0.045 | 0.047 |
| | 26 | 0.031 | 0.036 | 0.039 | 0.042 | 0.047 | 0.049 |
| | 27 | 0.032 | 0.037 | 0.040 | 0.043 | 0.048 | 0.050 |
| | 28 | 0.033 | 0.039 | 0.042 | 0.044 | 0.050 | 0.052 |
| | 29 | 0.034 | 0.040 | 0.043 | 0.046 | 0.051 | 0.053 |
| | 30 | 0.036 | 0.041 | 0.044 | 0.047 | 0.052 | 0.054 |
| | 31 | 0.037 | 0.042 | 0.046 | 0.048 | 0.054 | 0.056 |
| | 32 | 0.038 | 0.044 | 0.047 | 0.050 | 0.055 | 0.057 |
| | 33 | 0.039 | 0.045 | 0.048 | 0.051 | 0.057 | 0.059 |
| | 34 | 0.040 | 0.046 | 0.050 | 0.052 | 0.058 | 0.060 |
| | 35 | 0.041 | 0.047 | 0.051 | 0.054 | 0.059 | 0.062 |
| | 36 | 0.043 | 0.049 | 0.052 | 0.055 | 0.061 | 0.063 |
| | 37 | 0.044 | 0.050 | 0.053 | 0.056 | 0.062 | 0.064 |
| | 38 | 0.045 | 0.051 | 0.055 | 0.058 | 0.064 | 0.066 |
| | 39 | 0.046 | 0.052 | 0.056 | 0.059 | 0.065 | 0.067 |
| | 40 | 0.047 | 0.054 | 0.057 | 0.060 | 0.066 | 0.069 |
| | 41 | 0.049 | 0.055 | 0.059 | 0.062 | 0.068 | 0.070 |
| | 42 | 0.050 | 0.056 | 0.060 | 0.063 | 0.069 | 0.071 |
| | 43 | 0.051 | 0.057 | 0.061 | 0.064 | 0.070 | 0.073 |
| | 44 | 0.052 | 0.059 | 0.062 | 0.066 | 0.072 | 0.074 |
| | 45 | 0.053 | 0.060 | 0.064 | 0.067 | 0.073 | 0.075 |
| | 46 | 0.054 | 0.061 | 0.065 | 0.068 | 0.074 | 0.077 |
| | 47 | 0.056 | 0.062 | 0.066 | 0.069 | 0.076 | 0.078 |
| | 48 | 0.057 | 0.064 | 0.068 | 0.071 | 0.077 | 0.080 |
| | 49 | 0.058 | 0.065 | 0.069 | 0.072 | 0.078 | 0.081 |
| | 50 | 0.059 | 0.066 | 0.070 | 0.073 | 0.080 | 0.082 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 850 | 51 | 0.060 | 0.067 | 0.071 | 0.075 | 0.081 | 0.084 |
| | 52 | 0.061 | 0.069 | 0.073 | 0.076 | 0.083 | 0.085 |
| | 53 | 0.063 | 0.070 | 0.074 | 0.077 | 0.084 | 0.086 |
| | 54 | 0.064 | 0.071 | 0.075 | 0.079 | 0.085 | 0.088 |
| | 55 | 0.065 | 0.072 | 0.076 | 0.080 | 0.087 | 0.089 |
| | 56 | 0.066 | 0.074 | 0.078 | 0.081 | 0.088 | 0.090 |
| | 57 | 0.067 | 0.075 | 0.079 | 0.082 | 0.089 | 0.092 |
| | 58 | 0.068 | 0.076 | 0.080 | 0.084 | 0.091 | 0.093 |
| | 59 | 0.070 | 0.077 | 0.081 | 0.085 | 0.092 | 0.094 |
| | 60 | 0.071 | 0.079 | 0.083 | 0.086 | 0.093 | 0.096 |
| | 61 | 0.072 | 0.080 | 0.084 | 0.088 | 0.095 | 0.097 |
| | 62 | 0.073 | 0.081 | 0.085 | 0.089 | 0.096 | 0.098 |

Appendix 3B

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 900 | 0 | 0.000 | 0.001 | 0.002 | 0.003 | 0.005 | 0.005 |
| | 1 | 0.001 | 0.003 | 0.004 | 0.005 | 0.007 | 0.008 |
| | 2 | 0.002 | 0.004 | 0.005 | 0.006 | 0.009 | 0.010 |
| | 3 | 0.004 | 0.006 | 0.007 | 0.008 | 0.011 | 0.012 |
| | 4 | 0.005 | 0.007 | 0.008 | 0.010 | 0.012 | 0.013 |
| | 5 | 0.006 | 0.008 | 0.010 | 0.011 | 0.014 | 0.015 |
| | 6 | 0.007 | 0.010 | 0.011 | 0.013 | 0.016 | 0.017 |
| | 7 | 0.008 | 0.011 | 0.013 | 0.014 | 0.017 | 0.018 |
| | 8 | 0.009 | 0.012 | 0.014 | 0.015 | 0.019 | 0.020 |
| | 9 | 0.010 | 0.013 | 0.015 | 0.017 | 0.020 | 0.022 |
| | 10 | 0.011 | 0.015 | 0.017 | 0.018 | 0.022 | 0.023 |
| | 11 | 0.012 | 0.016 | 0.018 | 0.020 | 0.023 | 0.025 |
| | 12 | 0.014 | 0.017 | 0.019 | 0.021 | 0.025 | 0.026 |
| | 13 | 0.015 | 0.018 | 0.020 | 0.022 | 0.026 | 0.028 |
| | 14 | 0.016 | 0.020 | 0.022 | 0.024 | 0.028 | 0.029 |
| | 15 | 0.017 | 0.021 | 0.023 | 0.025 | 0.029 | 0.031 |
| | 16 | 0.018 | 0.022 | 0.024 | 0.026 | 0.030 | 0.032 |
| | 17 | 0.019 | 0.023 | 0.026 | 0.028 | 0.032 | 0.033 |
| | 18 | 0.020 | 0.024 | 0.027 | 0.029 | 0.033 | 0.035 |
| | 19 | 0.021 | 0.026 | 0.028 | 0.030 | 0.035 | 0.036 |
| | 20 | 0.022 | 0.027 | 0.029 | 0.032 | 0.036 | 0.038 |
| | 21 | 0.024 | 0.028 | 0.031 | 0.033 | 0.037 | 0.039 |
| | 22 | 0.025 | 0.029 | 0.032 | 0.034 | 0.039 | 0.041 |
| | 23 | 0.026 | 0.031 | 0.033 | 0.036 | 0.040 | 0.042 |
| | 24 | 0.027 | 0.032 | 0.034 | 0.037 | 0.041 | 0.043 |
| | 25 | 0.028 | 0.033 | 0.036 | 0.038 | 0.043 | 0.045 |
| | 26 | 0.029 | 0.034 | 0.037 | 0.039 | 0.044 | 0.046 |
| | 27 | 0.030 | 0.035 | 0.038 | 0.041 | 0.046 | 0.047 |
| | 28 | 0.031 | 0.037 | 0.039 | 0.042 | 0.047 | 0.049 |
| | 29 | 0.032 | 0.038 | 0.041 | 0.043 | 0.048 | 0.050 |
| | 30 | 0.034 | 0.039 | 0.042 | 0.044 | 0.050 | 0.051 |
| | 31 | 0.035 | 0.040 | 0.043 | 0.046 | 0.051 | 0.053 |
| | 32 | 0.036 | 0.041 | 0.044 | 0.047 | 0.052 | 0.054 |
| | 33 | 0.037 | 0.042 | 0.046 | 0.048 | 0.053 | 0.055 |
| | 34 | 0.038 | 0.044 | 0.047 | 0.049 | 0.055 | 0.057 |
| | 35 | 0.039 | 0.045 | 0.048 | 0.051 | 0.056 | 0.058 |
| | 36 | 0.040 | 0.046 | 0.049 | 0.052 | 0.057 | 0.059 |
| | 37 | 0.041 | 0.047 | 0.050 | 0.053 | 0.059 | 0.061 |
| | 38 | 0.042 | 0.048 | 0.052 | 0.054 | 0.060 | 0.062 |
| | 39 | 0.044 | 0.050 | 0.053 | 0.056 | 0.061 | 0.063 |
| | 40 | 0.045 | 0.051 | 0.054 | 0.057 | 0.063 | 0.065 |
| | 41 | 0.046 | 0.052 | 0.055 | 0.058 | 0.064 | 0.066 |
| | 42 | 0.047 | 0.053 | 0.057 | 0.059 | 0.065 | 0.067 |
| | 43 | 0.048 | 0.054 | 0.058 | 0.061 | 0.066 | 0.069 |
| | 44 | 0.049 | 0.055 | 0.059 | 0.062 | 0.068 | 0.070 |
| | 45 | 0.050 | 0.057 | 0.060 | 0.063 | 0.069 | 0.071 |
| | 46 | 0.051 | 0.058 | 0.061 | 0.064 | 0.070 | 0.073 |
| | 47 | 0.052 | 0.059 | 0.063 | 0.066 | 0.072 | 0.074 |
| | 48 | 0.054 | 0.060 | 0.064 | 0.067 | 0.073 | 0.075 |
| | 49 | 0.055 | 0.061 | 0.065 | 0.068 | 0.074 | 0.076 |
| | 50 | 0.056 | 0.062 | 0.066 | 0.069 | 0.075 | 0.078 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 900 | 51 | 0.057 | 0.064 | 0.067 | 0.071 | 0.077 | 0.079 |
| | 52 | 0.058 | 0.065 | 0.069 | 0.072 | 0.078 | 0.080 |
| | 53 | 0.059 | 0.066 | 0.070 | 0.073 | 0.079 | 0.082 |
| | 54 | 0.060 | 0.067 | 0.071 | 0.074 | 0.080 | 0.083 |
| | 55 | 0.061 | 0.068 | 0.072 | 0.075 | 0.082 | 0.084 |
| | 56 | 0.062 | 0.069 | 0.073 | 0.077 | 0.083 | 0.085 |
| | 57 | 0.064 | 0.071 | 0.075 | 0.078 | 0.084 | 0.087 |
| | 58 | 0.065 | 0.072 | 0.076 | 0.079 | 0.086 | 0.088 |
| | 59 | 0.066 | 0.073 | 0.077 | 0.080 | 0.087 | 0.089 |
| | 60 | 0.067 | 0.074 | 0.078 | 0.081 | 0.088 | 0.091 |

Table I (continued)

| N | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| 950 | 0 | 0.000 | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 |
| | 1 | 0.001 | 0.003 | 0.004 | 0.004 | 0.006 | 0.007 |
| | 2 | 0.002 | 0.004 | 0.005 | 0.006 | 0.008 | 0.009 |
| | 3 | 0.003 | 0.005 | 0.007 | 0.008 | 0.010 | 0.011 |
| | 4 | 0.004 | 0.007 | 0.008 | 0.009 | 0.012 | 0.013 |
| | 5 | 0.005 | 0.008 | 0.009 | 0.011 | 0.013 | 0.014 |
| | 6 | 0.007 | 0.009 | 0.011 | 0.012 | 0.015 | 0.016 |
| | 7 | 0.008 | 0.010 | 0.012 | 0.013 | 0.016 | 0.017 |
| | 8 | 0.009 | 0.011 | 0.013 | 0.015 | 0.018 | 0.019 |
| | 9 | 0.010 | 0.013 | 0.014 | 0.016 | 0.019 | 0.020 |
| | 10 | 0.011 | 0.014 | 0.016 | 0.017 | 0.021 | 0.022 |
| | 11 | 0.012 | 0.015 | 0.017 | 0.019 | 0.022 | 0.023 |
| | 12 | 0.013 | 0.016 | 0.018 | 0.020 | 0.023 | 0.025 |
| | 13 | 0.014 | 0.017 | 0.019 | 0.021 | 0.025 | 0.026 |
| | 14 | 0.015 | 0.019 | 0.021 | 0.022 | 0.026 | 0.028 |
| | 15 | 0.016 | 0.020 | 0.022 | 0.024 | 0.027 | 0.029 |
| | 16 | 0.017 | 0.021 | 0.023 | 0.025 | 0.029 | 0.030 |
| | 17 | 0.018 | 0.022 | 0.024 | 0.026 | 0.030 | 0.032 |
| | 18 | 0.019 | 0.023 | 0.025 | 0.027 | 0.031 | 0.033 |
| | 19 | 0.020 | 0.024 | 0.027 | 0.029 | 0.033 | 0.034 |
| | 20 | 0.021 | 0.025 | 0.028 | 0.030 | 0.034 | 0.036 |
| | 21 | 0.022 | 0.027 | 0.029 | 0.031 | 0.035 | 0.037 |
| | 22 | 0.023 | 0.028 | 0.030 | 0.032 | 0.037 | 0.038 |
| | 23 | 0.024 | 0.029 | 0.031 | 0.034 | 0.038 | 0.040 |
| | 24 | 0.025 | 0.030 | 0.033 | 0.035 | 0.039 | 0.041 |
| | 25 | 0.027 | 0.031 | 0.034 | 0.036 | 0.041 | 0.042 |
| | 26 | 0.028 | 0.032 | 0.035 | 0.037 | 0.042 | 0.044 |
| | 27 | 0.029 | 0.033 | 0.036 | 0.038 | 0.043 | 0.045 |
| | 28 | 0.030 | 0.035 | 0.037 | 0.040 | 0.044 | 0.046 |
| | 29 | 0.031 | 0.036 | 0.038 | 0.041 | 0.046 | 0.047 |
| | 30 | 0.032 | 0.037 | 0.040 | 0.042 | 0.047 | 0.049 |
| | 31 | 0.033 | 0.038 | 0.041 | 0.043 | 0.048 | 0.050 |
| | 32 | 0.034 | 0.039 | 0.042 | 0.044 | 0 049 | 0.051 |
| | 33 | 0.035 | 0.040 | 0.043 | 0.046 | 0.051 | 0.053 |
| | 34 | 0.036 | 0.041 | 0.044 | 0.047 | 0.052 | 0.054 |
| | 35 | 0.037 | 0.042 | 0.045 | 0.048 | 0.053 | 0.055 |
| | 36 | 0.038 | 0.044 | 0.047 | 0.049 | 0.054 | 0.056 |
| | 37 | 0.039 | 0.045 | 0.048 | 0.050 | 0.056 | 0.058 |
| | 38 | 0.040 | 0.046 | 0.049 | 0.052 | 0.057 | 0.059 |
| | 39 | 0.041 | 0.047 | 0.050 | 0.053 | 0.058 | 0.060 |
| | 40 | 0.042 | 0.048 | 0.051 | 0.054 | 0.059 | 0.061 |
| | 41 | 0.043 | 0.049 | 0.052 | 0.055 | 0.061 | 0.063 |
| | 42 | 0.044 | 0.050 | 0.054 | 0.056 | 0.062 | 0.064 |
| | 43 | 0.045 | 0.051 | 0.055 | 0.057 | 0.063 | 0.065 |
| | 44 | 0.047 | 0.053 | 0.056 | 0.059 | 0.064 | 0.066 |
| | 45 | 0.048 | 0.054 | 0.057 | 0.060 | 0.065 | 0.068 |
| | 46 | 0.049 | 0.055 | 0.058 | 0.061 | 0.067 | 0.069 |
| | 47 | 0.050 | 0.056 | 0.059 | 0.062 | 0.068 | 0.070 |
| | 48 | 0.051 | 0.057 | 0.060 | 0.063 | 0.069 | 0.071 |
| | 49 | 0.052 | 0.058 | 0.062 | 0.064 | 0.070 | 0.072 |
| | 50 | 0.053 | 0.059 | 0.063 | 0.066 | 0.071 | 0.074 |
| | 51 | 0.054 | 0.060 | 0.064 | 0.067 | 0.073 | 0.075 |

Table I (continued)

| $\frac{N}{1000}$ | F | C = .500 | .800 | .900 | .950 | .990 | .995 |
|---|---|---|---|---|---|---|---|
| | 0 | 0.000 | 0.001 | 0.002 | 0.002 | 0.004 | 0.005 |
| | 1 | 0.001 | 0.002 | 0.003 | 0.004 | 0.006 | 0.007 |
| | 2 | 0.002 | 0.004 | 0.005 | 0.006 | 0.008 | 0.009 |
| | 3 | 0.003 | 0.005 | 0.006 | 0.007 | 0.010 | 0.010 |
| | 4 | 0.004 | 0.006 | 0.007 | 0.009 | 0.011 | 0.012 |
| | 5 | 0.005 | 0.007 | 0.009 | 0.010 | 0.013 | 0.014 |
| | 6 | 0.006 | 0.009 | 0.010 | 0.011 | 0.014 | 0.015 |
| | 7 | 0.007 | 0.010 | 0.011 | 0.013 | 0.015 | 0.017 |
| | 8 | 0.008 | 0.011 | 0.012 | 0.014 | 0.017 | 0.018 |
| | 9 | 0.009 | 0.012 | 0.014 | 0.015 | 0.018 | 0.019 |
| | 10 | 0.010 | 0.013 | 0.015 | 0.016 | 0.020 | 0.021 |
| | 11 | 0.011 | 0.014 | 0.016 | 0.018 | 0.021 | 0.022 |
| | 12 | 0.012 | 0.015 | 0.017 | 0.019 | 0.022 | 0.023 |
| | 13 | 0.013 | 0.016 | 0.018 | 0.020 | 0.024 | 0.025 |
| | 14 | 0.014 | 0.018 | 0.020 | 0.021 | 0.025 | 0.026 |
| | 15 | 0.015 | 0.019 | 0.021 | 0.023 | 0.026 | 0.027 |
| | 16 | 0.016 | 0.020 | 0.022 | 0.024 | 0.027 | 0.029 |
| | 17 | 0.017 | 0.021 | 0.023 | 0.025 | 0.029 | 0.030 |
| | 18 | 0.018 | 0.022 | 0.024 | 0.026 | 0.030 | 0.031 |
| | 19 | 0.019 | 0.023 | 0.025 | 0.027 | 0.031 | 0.033 |
| | 20 | 0.020 | 0.024 | 0.026 | 0.028 | 0.032 | 0.034 |
| | 21 | 0.021 | 0.025 | 0.028 | 0.030 | 0.034 | 0.035 |
| | 22 | 0.022 | 0.026 | 0.029 | 0.031 | 0.035 | 0.036 |
| | 23 | 0.023 | 0.027 | 0.030 | 0.032 | 0.036 | 0.038 |
| | 24 | 0.024 | 0.029 | 0.031 | 0.033 | 0.037 | 0.039 |
| | 25 | 0.025 | 0.030 | 0.032 | 0.034 | 0.039 | 0.040 |
| | 26 | 0.026 | 0.031 | 0.033 | 0.035 | 0.040 | 0.041 |
| | 27 | 0.027 | 0.032 | 0.034 | 0.037 | 0.041 | 0.043 |
| | 28 | 0.028 | 0.033 | 0.035 | 0.038 | 0.042 | 0.044 |
| | 29 | 0.029 | 0.034 | 0.037 | 0.039 | 0.043 | 0.045 |
| | 30 | 0.030 | 0.035 | 0.038 | 0.040 | 0.045 | 0.046 |
| | 31 | 0.031 | 0.036 | 0.039 | 0.041 | 0.046 | 0.048 |
| | 32 | 0.032 | 0.037 | 0.040 | 0.042 | 0.047 | 0.049 |
| | 33 | 0.033 | 0.038 | 0.041 | 0.043 | 0.048 | 0.050 |
| | 34 | 0.034 | 0.039 | 0.042 | 0.045 | 0.049 | 0.051 |
| | 35 | 0.035 | 0.040 | 0.043 | 0.046 | 0.050 | 0.052 |
| | 36 | 0.036 | 0.041 | 0.044 | 0.047 | 0.052 | 0.054 |
| | 37 | 0.037 | 0.042 | 0.045 | 0.048 | 0.053 | 0.055 |
| | 38 | 0.038 | 0.043 | 0.046 | 0.049 | 0.054 | 0.056 |
| | 39 | 0.039 | 0.045 | 0.048 | 0.050 | 0.055 | 0.057 |
| | 40 | 0.040 | 0.046 | 0.049 | 0.051 | 0.056 | 0.058 |
| | 41 | 0.041 | 0.047 | 0.050 | 0.052 | 0.058 | 0.059 |
| | 42 | 0.042 | 0.048 | 0.051 | 0.053 | 0.059 | 0.061 |
| | 43 | 0.043 | 0.049 | 0.052 | 0.055 | 0.060 | 0.062 |
| | 44 | 0.044 | 0.050 | 0.053 | 0.056 | 0.061 | 0.063 |
| | 45 | 0.045 | 0.051 | 0.054 | 0.057 | 0.062 | 0.064 |
| | 46 | 0.046 | 0.052 | 0.055 | 0.058 | 0.063 | 0.065 |
| | 47 | 0.047 | 0.053 | 0.056 | 0.059 | 0.064 | 0.067 |
| | 48 | 0.048 | 0.054 | 0.057 | 0.060 | 0.066 | 0.068 |
| | 49 | 0.049 | 0.055 | 0.058 | 0.061 | 0.067 | 0.069 |
| | 50 | 0.050 | 0.056 | 0.060 | 0.062 | 0.068 | 0.070 |

APPENDIX 3B

Table 2

TWO-SIDED 90% CONFIDENCE LIMITS ON BINOMIAL p

| x \ n | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .950 | .000 | .776 | .000 | .631 | .000 | .527 | .000 | .451 |
| 1 | .050 | 1.000 | .025 | .975 | .017 | .865 | .013 | .751 | .010 | .658 |
| 2 | | | .224 | 1.000 | .135 | .983 | .098 | .902 | .076 | .811 |
| 3 | | | | | .369 | 1.000 | .249 | .987 | .189 | .924 |
| 4 | | | | | | | .473 | 1.000 | .342 | .990 |
| 5 | | | | | | | | | .549 | 1.000 |

| x \ n | 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .393 | .000 | .348 | .000 | .312 | .000 | .283 | .000 | .259 |
| 1 | .009 | .582 | .007 | .521 | .006 | .470 | .006 | .429 | .005 | .394 |
| 2 | .063 | .729 | .053 | .659 | .046 | .600 | .041 | .550 | .037 | .507 |
| 3 | .153 | .847 | .129 | .775 | .111 | .711 | .098 | .655 | .087 | .607 |
| 4 | .271 | .937 | .225 | .871 | .193 | .807 | .169 | .749 | .150 | .696 |
| 5 | .418 | .991 | .341 | .947 | .289 | .889 | .251 | .831 | .223 | .777 |
| 6 | .607 | 1.000 | .479 | .993 | .400 | .954 | .345 | .902 | .304 | .850 |
| 7 | | | .652 | 1.000 | .530 | .994 | .450 | .959 | .393 | .913 |
| 8 | | | | | .688 | 1.000 | .571 | .994 | .493 | .963 |
| 9 | | | | | | | .717 | 1.000 | .606 | .995 |
| 10 | | | | | | | | | .741 | 1.000 |

Table 2 (continued)

| x \ n | 11 | | 12 | | 13 | | 14 | | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .238 | .000 | .221 | .000 | .206 | .000 | .193 | .000 | .181 |
| 1 | .005 | .365 | .004 | .339 | .004 | .317 | .004 | .297 | .003 | .279 |
| 2 | .033 | .470 | .030 | .438 | .028 | .410 | .026 | .386 | .024 | .363 |
| 3 | .079 | .564 | .072 | .527 | .066 | .495 | .061 | .466 | .057 | .440 |
| 4 | .135 | .650 | .123 | .609 | .113 | .572 | .104 | .540 | .097 | .511 |
| 5 | .200 | .729 | .181 | .684 | .166 | .645 | .153 | .609 | .142 | .578 |
| 6 | .271 | .800 | .245 | .755 | .224 | .713 | .206 | .675 | .191 | .640 |
| 7 | .350 | .865 | .316 | .819 | .287 | .776 | .264 | .736 | .244 | .700 |
| 8 | .436 | .921 | .391 | .877 | .355 | .834 | .325 | .794 | .300 | .756 |
| 9 | .530 | .967 | .473 | .928 | .428 | .887 | .391 | .847 | .360 | .809 |
| 10 | .635 | .995 | .562 | .970 | .505 | .934 | .460 | .896 | .422 | .858 |
| 11 | .762 | 1.000 | .661 | .996 | .590 | .972 | .534 | .939 | .489 | .903 |
| 12 | | | .779 | 1.000 | .683 | .996 | .614 | .974 | .560 | .943 |
| 13 | | | | | .794 | 1.000 | .703 | .996 | .637 | .976 |
| 14 | | | | | | | .807 | 1.000 | .721 | .997 |
| 15 | | | | | | | | | .819 | 1.000 |

Example: Observed from sample 5/10. The 90% confidence limits for the population are .223 and .777.

| x \ n | 16 | | 17 | | 18 | | 19 | | 20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .171 | .000 | .162 | .000 | .153 | .000 | .146 | .000 | .139 |
| 1 | .003 | .264 | .003 | .250 | .003 | .238 | .003 | .226 | .003 | .216 |
| 2 | .023 | .344 | .021 | .326 | .020 | .310 | .019 | .296 | .018 | .282 |
| 3 | .053 | .417 | .050 | .396 | .047 | .377 | .044 | .359 | .042 | .344 |
| 4 | .090 | .484 | .085 | .461 | .080 | .439 | .075 | .419 | .071 | .401 |
| 5 | .132 | .549 | .124 | .522 | .116 | .498 | .110 | .476 | .104 | .455 |
| 6 | .178 | .608 | .166 | .580 | .156 | .554 | .147 | .529 | .139 | .507 |
| 7 | .227 | .667 | .212 | .636 | .199 | .608 | .188 | .582 | .177 | .558 |
| 8 | .279 | .721 | .260 | .689 | .244 | .659 | .229 | .632 | .217 | .606 |
| 9 | .333 | .773 | .311 | .740 | .291 | .709 | .274 | .679 | .259 | .653 |
| 10 | .392 | .822 | .364 | .788 | .341 | .756 | .321 | .726 | .302 | .698 |
| 11 | .451 | .868 | .420 | .834 | .392 | .801 | .368 | .771 | .347 | .741 |
| 12 | .516 | .910 | .478 | .876 | .446 | .844 | .418 | .812 | .394 | .783 |
| 13 | .583 | .947 | .539 | .915 | .502 | .884 | .471 | .853 | .442 | .823 |
| 14 | .656 | .977 | .604 | .950 | .561 | .920 | .524 | .890 | .493 | .861 |
| 15 | .736 | .997 | .674 | .979 | .622 | .953 | .581 | .925 | .545 | .896 |
| 16 | .829 | 1.000 | .750 | .997 | .690 | .980 | .641 | .956 | .599 | .929 |
| 17 | | | .838 | 1.000 | .762 | .997 | .704 | .981 | .656 | .958 |
| 18 | | | | | .847 | 1.000 | .774 | .997 | .718 | .982 |
| 19 | | | | | | | .854 | 1.000 | .784 | .997 |
| 20 | | | | | | | | | .861 | 1.000 |

Example: Observed from sample 10/20. The 90% confidence limits for the population are .302 and .698.

Table 2 (continued)

| x \ n | 22 | | 24 | | 26 | | 28 | | 30 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .127 | .000 | .117 | .000 | .109 | .000 | .101 | .000 | .095 |
| 1 | .002 | .198 | .002 | .183 | .002 | .170 | .002 | .158 | .002 | .149 |
| 2 | .016 | .260 | .015 | .240 | .014 | .223 | .013 | .208 | .012 | .196 |
| 3 | .038 | .316 | .035 | .292 | .032 | .272 | .030 | .254 | .028 | .238 |
| 4 | .065 | .370 | .059 | .342 | .054 | .318 | .050 | .297 | .047 | .280 |
| 5 | .094 | .420 | .086 | .389 | .079 | .362 | .073 | .339 | .068 | .319 |
| 6 | .124 | .468 | .115 | .435 | .106 | .406 | .098 | .379 | .091 | .357 |
| 7 | .160 | .515 | .146 | .479 | .134 | .447 | .124 | .419 | .115 | .394 |
| 8 | .196 | .561 | .178 | .522 | .163 | .487 | .151 | .457 | .140 | .429 |
| 9 | .233 | .605 | .211 | .563 | .194 | .526 | .179 | .493 | .166 | .466 |
| 10 | .271 | .647 | .246 | .603 | .226 | .564 | .208 | .531 | .193 | .499 |
| 11 | .311 | .689 | .282 | .643 | .259 | .602 | .238 | .565 | .221 | .533 |
| 12 | .353 | .729 | .319 | .681 | .292 | .638 | .270 | .600 | .249 | .567 |
| 13 | .395 | .767 | .357 | .718 | .327 | .673 | .301 | .633 | .279 | .597 |
| 14 | .439 | .804 | .397 | .754 | .362 | .708 | .333 | .667 | .308 | .630 |
| 15 | .485 | .840 | .437 | .789 | .398 | .741 | .367 | .699 | .339 | .661 |
| 16 | .532 | .876 | .478 | .822 | .436 | .774 | .400 | .730 | .370 | .692 |
| 17 | .580 | .906 | .521 | .854 | .474 | .806 | .435 | .762 | .403 | .721 |
| 18 | .630 | .935 | .565 | .885 | .513 | .837 | .469 | .792 | .433 | .751 |
| 19 | .684 | .962 | .611 | .914 | .553 | .866 | .507 | .821 | .467 | .779 |
| 20 | .740 | .984 | .658 | .941 | .594 | .894 | .543 | .849 | .501 | .807 |
| 21 | .802 | .998 | .708 | .965 | .638 | .921 | .581 | .876 | .534 | .834 |
| 22 | .873 | 1.000 | .760 | .985 | .682 | .946 | .621 | .902 | .571 | .860 |
| 23 | | | .817 | .998 | .728 | .968 | .661 | .927 | .606 | .885 |
| 24 | | | .883 | 1.000 | .777 | .986 | .703 | .950 | .643 | .909 |
| 25 | | | | | .830 | .998 | .746 | .970 | .681 | .932 |
| 26 | | | | | .891 | 1.000 | .792 | .987 | .720 | .953 |
| 27 | | | | | | | .842 | .998 | .762 | .972 |
| 28 | | | | | | | .899 | 1.000 | .804 | .988 |
| 29 | | | | | | | | | .851 | .998 |
| 30 | | | | | | | | | .905 | 1.000 |

**Example:** Observed from sample 6/30. The 90% confidence limits for the population are .091 and .357.

Appendix 3B

Table 2

TWO-SIDED 90% CONFIDENCE LIMITS ON BINOMIAL p

| x \ n | 35 | | 40 | |
|---|---|---|---|---|
| 0 | .000 | .082 | .000 | .072 |
| 1 | .001 | .128 | .001 | .113 |
| 2 | .010 | .169 | .009 | .149 |
| 3 | .024 | .206 | .021 | .183 |
| 4 | .040 | .243 | .035 | .215 |
| 5 | .058 | .277 | .051 | .245 |
| 6 | .078 | .311 | .067 | .275 |
| 7 | .098 | .343 | .085 | .304 |
| 8 | .119 | .374 | .103 | .331 |
| 9 | .141 | .405 | .123 | .360 |
| 10 | .163 | .436 | .142 | .387 |
| 11 | .187 | .467 | .162 | .414 |
| 12 | .211 | .496 | .184 | .441 |
| 13 | .235 | .524 | .204 | .466 |
| 14 | .261 | .553 | .226 | .492 |
| 15 | .286 | .581 | .247 | .518 |
| 16 | .311 | .609 | .269 | .543 |
| 17 | .337 | .636 | .292 | .567 |
| 18 | .364 | .663 | .314 | .592 |
| 19 | .391 | .689 | .338 | .615 |
| 20 | .419 | .714 | .362 | .638 |
| 21 | .447 | .739 | .385 | .662 |
| 22 | .476 | .765 | .408 | .686 |
| 23 | .504 | .789 | .433 | .708 |
| 24 | .533 | .813 | .457 | .731 |
| 25 | .564 | .837 | .482 | .753 |
| 26 | .595 | .859 | .508 | .774 |
| 27 | .626 | .881 | .534 | .796 |
| 28 | .657 | .902 | .559 | .816 |
| 29 | .689 | .922 | .586 | .838 |
| 30 | .723 | .942 | .613 | .858 |
| 31 | .757 | .960 | .640 | .877 |
| 32 | .794 | .976 | .669 | .897 |
| 33 | .831 | .990 | .696 | .915 |
| 34 | .872 | .999 | .725 | .933 |
| 35 | .918 | 1.000 | .755 | .949 |
| 36 | | | .785 | .965 |
| 37 | | | .817 | .979 |
| 38 | | | .851 | .991 |
| 39 | | | .887 | .999 |
| 40 | | | .928 | 1.000 |
| 41 | | | | |
| 42 | | | | |
| 43 | | | | |
| 44 | | | | |
| 45 | | | | |
| 46 | | | | |
| 47 | | | | |
| 48 | | | | |
| 49 | | | | |
| 50 | | | | |

**Example:** Observed from sample 35/50. The 90% confidence limits for the population are .576 and .805.

Table 2 (continued)

| x \ n | 45 | | 50 | |
|---|---|---|---|---|
| 0 | .000 | .064 | .000 | .058 |
| 1 | .001 | .101 | .001 | .091 |
| 2 | .008 | .133 | .007 | .120 |
| 3 | .018 | .163 | .017 | .148 |
| 4 | .031 | .192 | .028 | .174 |
| 5 | .045 | .220 | .040 | .199 |
| 6 | .060 | .246 | .054 | .223 |
| 7 | .075 | .273 | .067 | .247 |
| 8 | .092 | .297 | .082 | .270 |
| 9 | .108 | .323 | .097 | .293 |
| 10 | .126 | .348 | .113 | .316 |
| 11 | .144 | .372 | .129 | .337 |
| 12 | .162 | .397 | .145 | .359 |
| 13 | .180 | .419 | .161 | .381 |
| 14 | .199 | .442 | .178 | .403 |
| 15 | .218 | .467 | .195 | .424 |
| 16 | .238 | .489 | .212 | .444 |
| 17 | .258 | .512 | .229 | .464 |
| 18 | .277 | .533 | .247 | .486 |
| 19 | .296 | .555 | .266 | .506 |
| 20 | .317 | .576 | .282 | .525 |
| 21 | .337 | .598 | .302 | .545 |
| 22 | .359 | .621 | .320 | .565 |
| 23 | .379 | .641 | .338 | .586 |
| 24 | .402 | .663 | .357 | .605 |
| 25 | .424 | .683 | .375 | .625 |
| 26 | .445 | .704 | .395 | .643 |
| 27 | .467 | .723 | .414 | .662 |
| 28 | .488 | .742 | .435 | .680 |
| 29 | .511 | .762 | .455 | .698 |
| 30 | .533 | .782 | .475 | .718 |
| 31 | .558 | .801 | .494 | .734 |
| 32 | .581 | .820 | .514 | .753 |
| 33 | .603 | .838 | .536 | .771 |
| 34 | .628 | .856 | .556 | .788 |
| 35 | .652 | .874 | .576 | .805 |
| 36 | .677 | .892 | .597 | .822 |
| 37 | .703 | .908 | .619 | .839 |
| 38 | .727 | .925 | .641 | .855 |
| 39 | .754 | .940 | .663 | .871 |
| 40 | .780 | .955 | .684 | .887 |
| 41 | .808 | .969 | .707 | .903 |
| 42 | .837 | .982 | .730 | .918 |
| 43 | .867 | .992 | .753 | .933 |
| 44 | .899 | .999 | .777 | .946 |
| 45 | .936 | 1.000 | .801 | .960 |
| 46 | | | .826 | .972 |
| 47 | | | .852 | .983 |
| 48 | | | .880 | .993 |
| 49 | | | .909 | .999 |
| 50 | | | .942 | 1.000 |

**Example:** Observed from sample 35/50. The 90% confidence limits for the population are .576 and .805.

Table 2 (continued)

TWO-SIDED 90% CONFIDENCE LIMITS ON BINOMIAL p
n = 60

| x | | | x | | | x | | | x | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .049 | | | | | | | | | |
| 1 | .001 | .076 | 16 | .175 | .376 | 31 | .403 | .628 | 46 | .659 | .853 |
| 2 | .006 | .101 | 17 | .189 | .394 | 32 | .419 | .643 | 47 | .677 | .867 |
| 3 | .014 | .124 | 18 | .204 | .412 | 33 | .437 | .660 | 48 | .696 | .880 |
| 4 | .023 | .146 | 19 | .218 | .429 | 34 | .453 | .677 | 49 | .715 | .894 |
| 5 | .033 | .167 | 20 | .233 | .445 | 35 | .470 | .691 | 50 | .734 | .907 |
| 6 | .045 | .187 | 21 | .248 | .463 | 36 | .485 | .708 | 51 | .752 | .920 |
| 7 | .056 | .208 | 22 | .263 | .481 | 37 | .502 | .722 | 52 | .772 | .932 |
| 8 | .068 | .228 | 23 | .278 | .498 | 38 | .519 | .737 | 53 | .792 | .944 |
| 9 | .080 | .248 | 24 | .292 | .515 | 39 | .537 | .752 | 54 | .813 | .955 |
| 10 | .093 | .266 | 25 | .309 | .530 | 40 | .555 | .767 | 55 | .833 | .967 |
| 11 | .106 | .285 | 26 | .323 | .547 | 41 | .571 | .782 | 56 | .854 | .977 |
| 12 | .120 | .304 | 27 | .340 | .563 | 42 | .588 | .796 | 57 | .876 | .986 |
| 13 | .133 | .323 | 28 | .357 | .581 | 43 | .606 | .811 | 58 | .899 | .994 |
| 14 | .147 | .341 | 29 | .372 | .597 | 44 | .624 | .825 | 59 | .924 | .999 |
| 15 | .161 | .358 | 30 | .387 | .613 | 45 | .642 | .839 | 60 | .951 | 1.000 |

Table 2 (continued)

n = 80

| x | | | x | | | x | | | x | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .037 | | | | | | | | | |
| 1 | .001 | .058 | 21 | .183 | .356 | 41 | .414 | .610 | 61 | .672 | .838 |
| 2 | .004 | .077 | 22 | .194 | .368 | 42 | .428 | .621 | 62 | .685 | .849 |
| 3 | .010 | .094 | 23 | .205 | .382 | 43 | .440 | .633 | 63 | .698 | .860 |
| 4 | .017 | .111 | 24 | .216 | .395 | 44 | .452 | .644 | 64 | .712 | .870 |
| 5 | .025 | .127 | 25 | .228 | .408 | 45 | .465 | .657 | 65 | .726 | .881 |
| 6 | .033 | .143 | 26 | .240 | .422 | 46 | .477 | .669 | 66 | .741 | .891 |
| 7 | .042 | .158 | 27 | .250 | .436 | 47 | .490 | .680 | 67 | .754 | .901 |
| 8 | .051 | .173 | 28 | .262 | .447 | 48 | .503 | .692 | 68 | .768 | .911 |
| 9 | .060 | .188 | 29 | .274 | .460 | 49 | .515 | .703 | 69 | .783 | .921 |
| 10 | .069 | .203 | 30 | .284 | .472 | 50 | .528 | .716 | 70 | .797 | .931 |
| 11 | .079 | .217 | 31 | .297 | .485 | 51 | .540 | .726 | 71 | .812 | .940 |
| 12 | .089 | .232 | 32 | .308 | .497 | 52 | .553 | .738 | 72 | .827 | .949 |
| 13 | .099 | .246 | 33 | .320 | .510 | 53 | .564 | .750 | 73 | .842 | .958 |
| 14 | .109 | .259 | 34 | .331 | .523 | 54 | .578 | .760 | 74 | .857 | .967 |
| 15 | .119 | .274 | 35 | .343 | .535 | 55 | .592 | .772 | 75 | .873 | .975 |
| 16 | .130 | .288 | 36 | .356 | .548 | 56 | .605 | .784 | 76 | .8[illegible]9 | .983 |
| 17 | .140 | .302 | 37 | .367 | .560 | 57 | .618 | .795 | 77 | .906 | .990 |
| 18 | .151 | .315 | 38 | .379 | .572 | 58 | .632 | .806 | 78 | .923 | .996 |
| 19 | .162 | .328 | 39 | .390 | .586 | 59 | .644 | .817 | 79 | .942 | .999 |
| 20 | .172 | .343 | 40 | .402 | .598 | 60 | .657 | .828 | 80 | .963 | 1.000 |

**Example:** Observed from sample 50/80. The 90% confidence limits for the population are .528 and .716.

Table 2 (continued)

TWO-SIDED 90% CONFIDENCE LIMITS ON BINOMIAL p

n = 100

| x | | | x | | | x | | | x | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .030 | | | | | | | | | |
| 1 | .001 | .047 | 26 | .190 | .343 | 51 | .423 | .596 | 76 | .679 | .828 |
| 2 | .004 | .061 | 27 | .198 | .353 | 52 | .433 | .605 | 77 | .690 | .838 |
| 3 | .008 | .075 | 28 | .207 | .364 | 53 | .443 | .615 | 78 | .702 | .846 |
| 4 | .014 | .089 | 29 | .215 | .373 | 54 | .453 | .626 | 79 | .712 | .854 |
| 5 | .020 | .102 | 30 | .224 | .384 | 55 | .462 | .635 | 80 | .723 | .863 |
| 6 | .027 | .115 | 31 | .234 | .395 | 56 | .472 | .645 | 81 | .734 | .872 |
| 7 | .033 | .127 | 32 | .244 | .405 | 57 | .482 | .654 | 82 | .745 | .881 |
| 8 | .040 | .140 | 33 | .252 | .415 | 58 | .492 | .665 | 83 | .756 | .889 |
| 9 | .048 | .152 | 34 | .262 | .426 | 59 | .503 | .674 | 84 | .767 | .897 |
| 10 | .055 | .164 | 35 | .271 | .437 | 60 | .513 | .683 | 85 | .779 | .905 |
| 11 | .063 | .176 | 36 | .281 | .446 | 61 | .523 | .692 | 86 | .790 | .914 |
| 12 | .071 | .187 | 37 | .289 | .456 | 62 | .534 | .702 | 87 | .801 | .921 |
| 13 | .079 | .199 | 38 | .298 | .466 | 63 | .544 | .711 | 88 | .813 | .929 |
| 14 | .086 | .210 | 39 | .308 | .477 | 64 | .554 | .719 | 89 | .824 | .937 |
| 15 | .095 | .221 | 40 | .317 | .487 | 65 | .563 | .729 | 90 | .836 | .945 |
| 16 | .103 | .233 | 41 | .326 | .497 | 66 | .574 | .738 | 91 | .848 | .952 |
| 17 | .111 | .244 | 42 | .335 | .508 | 67 | .585 | .748 | 92 | .860 | .960 |
| 18 | .119 | .255 | 43 | .346 | .518 | 68 | .595 | .756 | 93 | .873 | .967 |
| 19 | .128 | .266 | 44 | .355 | .528 | 69 | .605 | .766 | 94 | .885 | .973 |
| 20 | .137 | .277 | 45 | .365 | .538 | 70 | .616 | .776 | 95 | .898 | .980 |
| 21 | .146 | .288 | 46 | .374 | .547 | 71 | .627 | .785 | 96 | .911 | .986 |
| 22 | .154 | .298 | 47 | .385 | .557 | 72 | .636 | .793 | 97 | .925 | .992 |
| 23 | .162 | .310 | 48 | .395 | .567 | 73 | .647 | .802 | 98 | .939 | .996 |
| 24 | .172 | .321 | 49 | .404 | .577 | 74 | .657 | .810 | 99 | .953 | .999 |
| 25 | .181 | .331 | 50 | .414 | .586 | 75 | .669 | .819 | 100 | .970 | 1.000 |

**Example:** Observed from sample 50/100. The 90% confidence limits for the population are .414 and .586.

Appendix 3B

Table 2 (continued)

95% CONFIDENCE INTERVAL FOR BINOMIAL DISTRIBUTION

The following lists the 95% confidence interval for the binomial distribution. These tables are similar to the 90% tables.

TWO-SIDED 95% CONFIDENCE LIMITS ON BINOMIAL p

| x \ n | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .975 | .000 | .842 | .000 | .708 | .000 | .602 | .000 | .522 |
| 1 | .025 | 1.000 | .013 | .987 | .008 | .906 | .006 | .806 | .005 | .716 |
| 2 | | | .158 | 1.000 | .094 | .992 | .068 | .932 | .053 | .853 |
| 3 | | | | | .292 | 1.000 | .194 | .994 | .147 | .947 |
| 4 | | | | | | | .398 | 1.000 | .284 | .995 |
| 5 | | | | | | | | | .478 | 1.000 |

| x \ n | 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .459 | .000 | .410 | .000 | .369 | .000 | .336 | .000 | .308 |
| 1 | .004 | .641 | .004 | .579 | .003 | .527 | .003 | .483 | .003 | .445 |
| 2 | .043 | .777 | .037 | .710 | .032 | .651 | .028 | .600 | .025 | .556 |
| 3 | .118 | .882 | .099 | .816 | .085 | .755 | .075 | .701 | .067 | .652 |
| 4 | .223 | .957 | .184 | .901 | .157 | .843 | .137 | .788 | .122 | .738 |
| 5 | .359 | .996 | .290 | .963 | .245 | .915 | .212 | .863 | .187 | .813 |
| 6 | | 1.000 | .421 | .996 | .349 | .968 | .299 | .925 | .262 | .878 |
| 7 | | | .590 | 1.000 | .473 | .997 | .400 | .972 | .348 | .933 |
| 8 | | | | | .631 | 1.000 | .517 | .997 | .444 | .975 |
| 9 | | | | | | | .664 | 1.000 | .555 | .997 |
| 10 | | | | | | | | | .692 | 1.000 |

Appendix 3B

Table 2 (continued)

| x \ n | 11 | | 12 | | 13 | | 14 | | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .285 | .000 | .265 | .000 | .247 | .000 | .232 | .000 | .218 |
| 1 | .002 | .413 | .002 | .385 | .002 | .360 | .002 | .339 | .002 | .319 |
| 2 | .023 | .518 | .021 | .484 | .019 | .454 | .018 | .428 | .017 | .405 |
| 3 | .060 | .610 | .055 | .572 | .050 | .538 | .047 | .508 | .043 | .481 |
| 4 | .109 | .692 | .099 | .651 | .091 | .614 | .084 | .581 | .078 | .551 |
| 5 | .167 | .766 | .151 | .723 | .139 | .684 | .128 | .649 | .118 | .616 |
| 6 | .234 | .833 | .211 | .789 | .192 | .749 | .177 | .711 | .163 | .677 |
| 7 | .308 | .891 | .277 | .849 | .251 | .808 | .230 | .770 | .213 | .734 |
| 8 | .390 | .940 | .349 | .901 | .316 | .861 | .289 | .823 | .266 | .787 |
| 9 | .482 | .977 | .428 | .945 | .386 | .909 | .351 | .872 | .323 | .837 |
| 10 | .587 | .998 | .516 | .979 | .462 | .950 | .419 | .916 | .384 | .882 |
| 11 | .715 | 1.000 | .615 | .998 | .546 | .981 | .492 | .953 | .449 | .922 |
| 12 | | | .735 | 1.000 | .640 | .998 | .572 | .982 | .519 | .957 |
| 13 | | | | | .753 | 1.000 | .661 | .998 | .595 | .983 |
| 14 | | | | | | | .768 | 1.000 | .681 | .998 |
| 15 | | | | | | | | | .782 | 1.000 |

Example: Observed from sample 5/10. The 95% confidence limits for the population are .187 and .813.

Appendix 3B

Table 2 (continued)

| x \ n | 16 | | 17 | | 18 | | 19 | | 20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .206 | .000 | .195 | .000 | .185 | .000 | .176 | .000 | .168 |
| 1 | .002 | .302 | .001 | .287 | .001 | .273 | .001 | .260 | .001 | .249 |
| 2 | .016 | .383 | .015 | .364 | .014 | .347 | .013 | .331 | .012 | .317 |
| 3 | .040 | .456 | .038 | .434 | .036 | .414 | .034 | .396 | .032 | .379 |
| 4 | .073 | .524 | .068 | .499 | .064 | .476 | .061 | .456 | .057 | .437 |
| 5 | .110 | .587 | .103 | .560 | .097 | .535 | .091 | .512 | .087 | .491 |
| 6 | .152 | .646 | .142 | .617 | .133 | .590 | .126 | .565 | .119 | .543 |
| 7 | .198 | .701 | .184 | .671 | .173 | .643 | .163 | .616 | .154 | .592 |
| 8 | .247 | .753 | .230 | .722 | .215 | .692 | .203 | .665 | .191 | .639 |
| 9 | .299 | .802 | .278 | .770 | .260 | .740 | .244 | .711 | .231 | .685 |
| 10 | .354 | .848 | .329 | .816 | .308 | .785 | .289 | .756 | .272 | .728 |
| 11 | .413 | .890 | .383 | .858 | .357 | .827 | .335 | .797 | .315 | .769 |
| 12 | .476 | .927 | .440 | .897 | .410 | .867 | .384 | .837 | .361 | .809 |
| 13 | .544 | .960 | .501 | .932 | .465 | .903 | .435 | .874 | .408 | .846 |
| 14 | .617 | .984 | .566 | .962 | .524 | .936 | .388 | .909 | .457 | .881 |
| 15 | .698 | .998 | .636 | .985 | .586 | .964 | .544 | .939 | .509 | .913 |
| 16 | .794 | 1.000 | .713 | [illegible] | .653 | .986 | .604 | .966 | .563 | .943 |
| 17 | | | .805 | 1.000 | .727 | .999 | .669 | .987 | .621 | .968 |
| 18 | | | | | .815 | 1.000 | .740 | .999 | .683 | .988 |
| 19 | | | | | | | .824 | 1.000 | .751 | .999 |
| 20 | | | | | | | | | .832 | 1.000 |

Table 2 (continued)

| x \ n | 21 | | 22 | | 23 | | 24 | | 25 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .161 | .000 | .154 | .000 | .148 | .000 | .142 | .000 | .137 |
| 1 | .001 | .238 | .001 | .229 | .001 | .219 | .001 | .211 | .001 | .203 |
| 2 | .012 | .304 | .011 | .292 | .011 | .281 | .010 | .270 | | |
| 3 | .030 | .363 | .029 | .349 | .028 | .336 | .027 | .323 | .025 | .312 |
| 4 | .054 | .419 | .052 | .403 | .050 | .388 | .047 | .374 | | |
| 5 | .082 | .471 | .078 | .453 | .075 | .436 | .071 | .421 | .068 | .407 |
| 6 | .113 | .522 | .107 | .502 | .102 | .484 | .098 | .467 | .094 | .451 |
| 7 | .146 | .570 | .139 | .549 | .132 | .529 | .126 | .512 | .121 | .494 |
| 8 | .181 | .616 | .172 | .593 | .164 | .573 | .156 | .553 | .149 | .535 |
| 9 | .218 | .660 | .207 | .636 | .197 | .615 | .188 | .594 | .180 | .575 |
| 10 | .257 | .702 | .244 | .678 | .232 | .655 | .221 | .634 | .211 | .614 |
| 11 | .298 | .743 | .282 | .718 | .268 | .694 | .256 | .672 | .244 | .651 |
| 12 | .340 | .782 | .322 | .756 | .306 | .732 | .291 | .709 | .278 | .687 |
| 13 | .384 | .819 | .364 | .793 | .345 | .768 | .328 | .744 | .313 | .722 |
| 14 | .430 | .854 | .407 | .828 | .385 | .803 | .366 | .779 | .349 | .756 |
| 15 | .478 | .887 | .451 | .861 | .427 | .836 | .406 | .812 | .386 | .789 |
| 16 | .529 | .918 | .498 | .893 | .471 | .868 | .447 | .844 | .425 | .820 |
| 17 | .581 | .946 | .547 | .922 | .516 | .898 | .488 | .874 | .465 | .851 |
| 18 | .637 | .970 | .597 | .948 | .564 | .925 | .533 | .902 | .506 | .879 |
| 19 | .696 | .988 | .651 | .971 | .612 | .950 | .579 | .929 | .549 | .906 |
| 20 | .762 | .999 | .708 | .989 | .664 | .972 | .626 | .953 | .593 | .932 |
| 21 | .839 | 1.000 | .771 | .999 | .719 | .989 | .677 | .973 | | |
| 22 | | | .846 | 1.000 | .781 | .999 | .730 | .990 | .688 | .975 |
| 23 | | | | | .852 | 1.000 | .789 | .999 | | |
| 24 | | | | | | | .858 | 1.000 | .797 | .999 |
| 25 | | | | | | | | | .863 | 1.000 |

Example: Observed from sample 10/25. The 95% confidence limits for the population are .211 and .614.

Table 2 (continued)

| x \ n | 26 | | 28 | | 30 | | 35 | | 40 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .132 | .000 | .123 | .000 | .116 | .000 | .100 | .000 | .088 |
| 1 | .001 | .197 | .001 | .184 | .001 | .172 | .001 | .149 | .001 | .132 |
| 2 | .009 | .251 | .009 | .235 | .008 | .221 | .007 | .192 | .006 | .169 |
| 3 | .024 | .301 | .023 | .282 | .021 | .265 | .018 | .230 | .016 | .204 |
| 4 | .044 | .349 | .040 | .327 | .038 | .307 | .032 | .268 | .028 | .236 |
| 5 | .066 | .393 | .061 | .369 | .056 | .348 | .048 | .303 | .042 | .268 |
| 6 | .090 | .436 | .083 | .410 | .077 | .386 | .066 | .336 | .057 | .298 |
| 7 | .116 | .478 | .107 | .449 | .099 | .423 | .084 | .369 | .073 | .328 |
| 8 | .143 | .518 | .132 | .487 | .123 | .459 | .104 | .401 | .090 | .357 |
| 9 | .172 | .557 | .159 | .524 | .148 | .494 | .125 | .433 | .109 | .385 |
| 10 | .202 | .595 | .186 | .560 | .173 | .528 | .147 | .463 | .127 | .412 |
| 11 | .234 | .631 | .215 | .594 | .199 | .561 | .169 | .493 | .146 | .439 |
| 12 | .266 | .666 | .245 | .628 | .227 | .594 | .192 | .522 | .166 | .465 |
| 13 | .299 | .701 | .275 | .661 | .255 | .626 | .215 | .551 | .185 | .491 |
| 14 | .334 | .734 | .306 | .694 | .283 | .657 | .239 | .578 | .206 | .517 |
| 15 | .369 | .766 | .339 | .725 | .313 | .687 | .263 | .607 | .227 | .542 |
| 16 | .405 | .798 | .372 | .755 | .343 | .717 | .288 | .634 | .249 | .567 |
| 17 | .443 | .828 | .406 | .785 | .374 | .745 | .314 | .660 | .271 | .590 |
| 18 | .482 | .857 | .440 | .814 | .406 | .773 | .340 | .686 | .293 | .615 |
| 19 | .522 | .884 | .476 | .841 | .439 | .801 | .366 | .712 | .315 | .639 |
| 20 | .564 | .910 | .513 | .868 | .472 | .827 | .393 | .737 | .338 | .662 |
| 21 | .607 | .934 | .551 | .893 | .506 | .852 | .422 | .761 | .361 | .685 |
| 22 | .651 | .956 | .590 | .917 | .541 | .877 | .449 | .785 | .385 | .707 |
| 23 | .699 | .976 | .631 | .939 | .577 | .901 | .478 | .808 | .410 | .729 |
| 24 | .749 | .991 | .673 | .960 | .614 | .923 | .507 | .831 | .433 | .751 |
| 25 | .803 | .999 | .718 | .977 | .652 | .944 | .537 | .853 | .458 | .773 |
| 26 | .868 | 1.000 | .765 | .991 | .693 | .962 | .567 | .875 | .483 | .794 |
| 27 | | | .816 | .999 | .735 | .979 | .599 | .896 | .509 | .815 |
| 28 | | | .877 | 1.000 | .779 | .992 | .631 | .916 | .535 | .834 |
| 29 | | | | | .828 | .999 | .664 | .934 | .561 | .854 |
| 30 | | | | | .884 | 1.000 | .697 | .952 | .588 | .873 |
| 31 | | | | | | | .732 | .968 | .615 | .891 |
| 32 | | | | | | | .770 | .982 | .643 | .910 |
| 33 | | | | | | | .808 | .993 | .672 | .927 |
| 34 | | | | | | | .851 | .999 | .702 | .943 |
| 35 | | | | | | | .900 | 1.000 | .732 | .958 |
| 36 | | | | | | | | | .764 | .972 |
| 37 | | | | | | | | | .796 | .984 |
| 38 | | | | | | | | | .831 | .994 |
| 39 | | | | | | | | | .868 | .999 |
| 40 | | | | | | | | | .912 | 1.000 |

**Example:** Observed from sample 25/40. The 95% confidence limits for the population are .458 and .773.

Appendix 3B

Table 2 (continued)

n = 50

| X | | |
|---|---|---|
| 0 | .000 | .071 |
| 1 | .001 | .106 |
| 2 | .005 | .137 |
| 3 | .013 | .165 |
| 4 | .022 | .192 |
| 5 | .033 | .218 |
| 6 | .045 | .243 |
| 7 | .058 | .267 |
| 8 | .072 | .291 |
| 9 | .086 | .314 |
| 10 | .100 | .338 |
| 11 | .115 | .360 |
| 12 | .131 | .381 |
| 13 | .146 | .404 |
| 14 | .163 | .424 |
| 15 | .179 | .446 |
| 16 | .195 | .467 |
| 17 | .212 | .488 |
| 18 | .229 | .508 |
| 19 | .247 | .527 |
| 20 | .264 | .548 |
| 21 | .282 | .568 |
| 22 | .300 | .588 |
| 23 | .318 | .606 |
| 24 | .337 | .626 |
| 25 | .356 | .644 |

| X | | |
|---|---|---|
| 26 | .374 | .663 |
| 27 | .394 | .682 |
| 28 | .412 | .700 |
| 29 | .432 | .718 |
| 30 | .452 | .736 |
| 31 | .473 | .753 |
| 32 | .492 | .771 |
| 33 | .512 | .788 |
| 34 | .533 | .805 |
| 35 | .554 | .821 |
| 36 | .576 | .837 |
| 37 | .596 | .854 |
| 38 | .619 | .869 |
| 39 | .640 | .885 |
| 40 | .662 | .900 |
| 41 | .686 | .914 |
| 42 | .709 | .928 |
| 43 | .733 | .942 |
| 44 | .757 | .955 |
| 45 | .782 | .967 |
| 46 | .808 | .978 |
| 47 | .835 | .987 |
| 48 | .863 | .995 |
| 49 | .894 | .999 |
| 50 | .929 | 1.000 |

**Example:** Observed from sample 15/50. The 95% confidence limits for the population are .179 and .446.

Appendix 3B

Table 2 (continued)

n = 100

| x | | | x | | | | | | x | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .036 | | | | | | | | | |
| 1 | .000 | .054 | 26 | .177 | .357 | 51 | .408 | .611 | 76 | .664 | .839 |
| 2 | .002 | .070 | 27 | .187 | .368 | 52 | .418 | .620 | 77 | .676 | .848 |
| 3 | .006 | .085 | 28 | .195 | .378 | 53 | .427 | .630 | 78 | .686 | .856 |
| 4 | .011 | .099 | 29 | .204 | .390 | 54 | .437 | .639 | 79 | .697 | .865 |
| 5 | .016 | .113 | 30 | .213 | .399 | 55 | .447 | .650 | 80 | .708 | .874 |
| 6 | .022 | .126 | 31 | .221 | .410 | 56 | .457 | .659 | 81 | .719 | .881 |
| 7 | .029 | .139 | 32 | .230 | .420 | 57 | .467 | .668 | 82 | .731 | .890 |
| 8 | .035 | .152 | 33 | .240 | .431 | 58 | .477 | .678 | 83 | .742 | .898 |
| 9 | .042 | .164 | 34 | .248 | .441 | 59 | .487 | .687 | 84 | .753 | .906 |
| 10 | .049 | .176 | 35 | .257 | .452 | 60 | .497 | .697 | 85 | .764 | .914 |
| 11 | .056 | .188 | 36 | .266 | .463 | 61 | .507 | .706 | 86 | .777 | .922 |
| 12 | .064 | .200 | 37 | .276 | .472 | 62 | .518 | .716 | 87 | .788 | .929 |
| 13 | .071 | .212 | 38 | .284 | .482 | 63 | .528 | .724 | 88 | .800 | .936 |
| 14 | .078 | .223 | 39 | .294 | .493 | 64 | .537 | .734 | 89 | .812 | .944 |
| 15 | .086 | .236 | 40 | .303 | .503 | 65 | .548 | .743 | 90 | .824 | .951 |
| 16 | .094 | .247 | 41 | .313 | .513 | 66 | .559 | .752 | 91 | .836 | .958 |
| 17 | .102 | .258 | 42 | .322 | .523 | 67 | .569 | .760 | 92 | .848 | .965 |
| 18 | .110 | .269 | 43 | .332 | .533 | 68 | .580 | .770 | 93 | .861 | .971 |
| 19 | .119 | .281 | 44 | .341 | .543 | 69 | .590 | .779 | 94 | .874 | .978 |
| 20 | .126 | .292 | 45 | .350 | .553 | 70 | .601 | .787 | 95 | .887 | .984 |
| 21 | .135 | .303 | 46 | .361 | .563 | 71 | .610 | .796 | 96 | .901 | .989 |
| 22 | .144 | .314 | 47 | .370 | .573 | 72 | .622 | .805 | 97 | .915 | .994 |
| 23 | .152 | .324 | 48 | .380 | .582 | 73 | .632 | .813 | 98 | .930 | .998 |
| 24 | .161 | .336 | 49 | .389 | .592 | 74 | .643 | .823 | 99 | .946 | 1.000 |
| 25 | .169 | .347 | 50 | .398 | .602 | 75 | .653 | .831 | 100 | .964 | 1.000 |

Example: Observed from sample 50/100. The 95% confidence limits for the population are .398 and .602.

Appendix 3B

Table 2 (continued)

99% CONFIDENCE INTERVAL FOR BINOMIAL DISTRIBUTION

The following lists the 99% confidence interval for the binomial distribution. These tables are similar to the 90% tables.

TWO-SIDED 99% CONFIDENCE LIMITS ON BINOMIAL p

| x \ n | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .995 | .000 | .929 | .000 | .829 | .000 | .734 | .000 | .653 |
| 1 | .005 | 1.000 | .003 | .997 | .002 | .959 | .001 | .889 | .001 | .815 |
| 2 | | | .071 | 1.000 | .041 | .998 | .029 | .971 | .023 | .917 |
| 3 | | | | | .171 | 1.000 | .111 | .999 | .083 | .977 |
| 4 | | | | | | | .266 | 1.000 | .185 | .999 |
| 5 | | | | | | | | | .347 | 1.000 |

| x \ n | 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .586 | .000 | .531 | .000 | .484 | .000 | .445 | .000 | .411 |
| 1 | .001 | .746 | .001 | .685 | .001 | .632 | .001 | .585 | .001 | .544 |
| 2 | .019 | .856 | .016 | .797 | .014 | .742 | .012 | .693 | .011 | .648 |
| 3 | .066 | .934 | .055 | .882 | .047 | .830 | .042 | .781 | .037 | .735 |
| 4 | .144 | .981 | .118 | .945 | .100 | .900 | .087 | .854 | .077 | .809 |
| 5 | .254 | .999 | .203 | .984 | .170 | .953 | .146 | .913 | .128 | .872 |
| 6 | .414 | 1.000 | .315 | .999 | .258 | .986 | .219 | .958 | .191 | .923 |
| 7 | | | .469 | 1.000 | .368 | .999 | .307 | .988 | .265 | .963 |
| 8 | | | | | .516 | 1.000 | .415 | .999 | .352 | .989 |
| 9 | | | | | | | .555 | 1.000 | .456 | .999 |
| 10 | | | | | | | | | .589 | 1.000 |

Table 2 (continued)

| x \ n | 11 | | 12 | | 13 | | 14 | | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .382 | .000 | .357 | .000 | .335 | .000 | .315 | .000 | .298 |
| 1 | .000 | .509 | .000 | .477 | .000 | .449 | .000 | .424 | .000 | .402 |
| 2 | .010 | .608 | .009 | .573 | .008 | .541 | .008 | .512 | .007 | .486 |
| 3 | .033 | .693 | .030 | .655 | .028 | .621 | .026 | .589 | .024 | .561 |
| 4 | .069 | .767 | .062 | .728 | .057 | .691 | .053 | .658 | .049 | .627 |
| 5 | .114 | .831 | .103 | .791 | .094 | .755 | .087 | .720 | .080 | .688 |
| 6 | .169 | .886 | .152 | .848 | .138 | .811 | .127 | .777 | .117 | .744 |
| 7 | .233 | .931 | .209 | .897 | .189 | .862 | .172 | .828 | .159 | .795 |
| 8 | .307 | .967 | .272 | .938 | .245 | .906 | .223 | .873 | .205 | .841 |
| 9 | .392 | .990 | .345 | .970 | .309 | .943 | .280 | .913 | .256 | .883 |
| 10 | .491 | 1.000 | .427 | .991 | .379 | .972 | .342 | .947 | .312 | .920 |
| 11 | .618 | 1.000 | .523 | 1.000 | .459 | .992 | .411 | .974 | .373 | .951 |
| 12 | | | .643 | 1.000 | .551 | 1.000 | .488 | .992 | .439 | .976 |
| 13 | | | | | .665 | 1.000 | .576 | 1.000 | .514 | .993 |
| 14 | | | | | | | .685 | 1.000 | .598 | 1.000 |
| 15 | | | | | | | | | .702 | 1.000 |

Example: Observed from sample 5/10. The 99% confidence limits for the population are .128 and .872.

Appendix 3B

Table 2 (continued)

| x \ n | 16 | | 17 | | 18 | | 19 | | 20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .282 | .000 | .268 | .000 | .255 | .000 | .243 | .000 | .233 |
| 1 | .000 | .381 | .000 | .363 | .000 | .346 | .000 | .331 | .000 | .317 |
| 2 | .007 | .463 | .006 | .441 | .006 | .422 | .006 | .404 | .005 | .387 |
| 3 | .022 | .534 | .021 | .510 | .020 | .488 | .019 | .468 | .018 | .449 |
| 4 | .045 | .599 | .043 | .573 | .040 | .549 | .038 | .527 | .036 | .507 |
| 5 | .075 | .658 | .070 | .631 | .065 | .605 | .062 | .582 | .058 | .560 |
| 6 | .109 | .714 | .101 | .685 | .095 | .658 | .090 | .633 | .085 | .610 |
| 7 | .147 | .764 | .137 | .735 | .128 | .707 | .121 | .681 | .114 | .657 |
| 8 | .189 | .811 | .176 | .781 | .165 | .753 | .155 | .726 | .146 | .701 |
| 9 | .236 | .853 | .219 | .824 | .205 | .795 | .192 | .768 | .181 | .743 |
| 10 | .286 | .891 | .265 | .863 | .247 | .835 | .232 | .808 | .218 | .782 |
| 11 | .342 | .925 | .315 | .899 | .293 | .872 | .274 | .845 | .257 | .819 |
| 12 | .401 | .955 | .369 | .930 | .342 | .905 | .319 | .879 | .299 | .854 |
| 13 | .466 | .978 | .427 | .957 | .395 | .935 | .367 | .910 | .343 | .886 |
| 14 | .537 | .993 | .490 | .979 | .451 | .960 | .418 | .938 | .390 | .915 |
| 15 | .619 | 1.000 | .559 | .994 | .512 | .980 | .473 | .962 | .440 | .942 |
| 16 | .718 | 1.000 | .637 | 1.000 | .578 | .994 | .532 | .981 | .493 | .964 |
| 17 | | | .732 | 1.000 | .654 | 1.000 | .596 | .994 | .551 | .982 |
| 18 | | | | | .745 | 1.000 | .669 | 1.000 | .613 | .995 |
| 19 | | | | | | | .757 | 1.000 | .683 | 1.000 |
| 20 | | | | | | | | | .767 | 1.000 |

Example: Observed from sample 10/20. The 99% confidence limits for the population are .218 and .782.

## Appendix 3B

Table 2 (continued)

| x \ n | 22 | | 24 | | 26 | | 28 | | 30 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .000 | .214 | .000 | .198 | .000 | .184 | .000 | .172 | .000 | .162 |
| 1 | .000 | .292 | .000 | .271 | .000 | .253 | .000 | .237 | .000 | .223 |
| 2 | .005 | .358 | .004 | .332 | .004 | .310 | .004 | .291 | .004 | .274 |
| 3 | .016 | .416 | .015 | .387 | .013 | .362 | .012 | .340 | .012 | .320 |
| 4 | .032 | .470 | .029 | .438 | .027 | .410 | .025 | .385 | .023 | .363 |
| 5 | .053 | .520 | .048 | .485 | .044 | .455 | .041 | .428 | .038 | .404 |
| 6 | .076 | .567 | .069 | .531 | .064 | .498 | .059 | .469 | .054 | .443 |
| 7 | .102 | .612 | .093 | .573 | .085 | .538 | .078 | .508 | .073 | .480 |
| 8 | .131 | .655 | .119 | .614 | .109 | .578 | .100 | .545 | .093 | .516 |
| 9 | .162 | .695 | .146 | .653 | .134 | .615 | .123 | .581 | .114 | .550 |
| 10 | .195 | .734 | .176 | .690 | .161 | .651 | .148 | .616 | .137 | .583 |
| 11 | .229 | .771 | .207 | .726 | .189 | .686 | .173 | .649 | .160 | .616 |
| 12 | .266 | .805 | .240 | .760 | .218 | .719 | .200 | .682 | .185 | .647 |
| 13 | .305 | .838 | .274 | .793 | .249 | .751 | .228 | .713 | .211 | .678 |
| 14 | .345 | .869 | .310 | .824 | .281 | .782 | .257 | .743 | .237 | .707 |
| 15 | .388 | .898 | .347 | .854 | .314 | .811 | .287 | .772 | .265 | .735 |
| 16 | .433 | .924 | .386 | .881 | .349 | .839 | .318 | .800 | .293 | .763 |
| 17 | .480 | .947 | .427 | .907 | .385 | .866 | .351 | .827 | .322 | .789 |
| 18 | .530 | .968 | .469 | .931 | .422 | .891 | .384 | .852 | .353 | .815 |
| 19 | .584 | .984 | .515 | .952 | .462 | .915 | .419 | .877 | .384 | .840 |
| 20 | .642 | .995 | .562 | .971 | .502 | .936 | .455 | .900 | .417 | .863 |
| 21 | .708 | 1.000 | .613 | .985 | .545 | .956 | .492 | .922 | .450 | .886 |
| 22 | .786 | 1.000 | .668 | .996 | .590 | .973 | .531 | .941 | .484 | .907 |
| 23 | | | .729 | 1.000 | .638 | .987 | .572 | .959 | .520 | .927 |
| 24 | | | .802 | 1.000 | .690 | .996 | .615 | .975 | .557 | .946 |
| 25 | | | | | .747 | 1.000 | .660 | .988 | .596 | .962 |
| 26 | | | | | .816 | 1.000 | .709 | .996 | .637 | .977 |
| 27 | | | | | | | .763 | 1.000 | .680 | .988 |
| 28 | | | | | | | 8.28 | 1.000 | .726 | .996 |
| 29 | | | | | | | | | .777 | 1.000 |
| 30 | | | | | | | | | .838 | 1.000 |

Example: Observed from sample 6/30. The 99% confidence limits for the population are .054 and .443.

Appendix 3B

Table 2 (continued)

| x \ n | 35 | | 40 | |
|---|---|---|---|---|
| 0 | .000 | .140 | .000 | .124 |
| 1 | .000 | .194 | .000 | .172 |
| 2 | .003 | .239 | .003 | .212 |
| 3 | .010 | .280 | .009 | .249 |
| 4 | .020 | .318 | .017 | .283 |
| 5 | .032 | .354 | .028 | .315 |
| 6 | .046 | .389 | .040 | .346 |
| 7 | .062 | .422 | .054 | .376 |
| 8 | .079 | .455 | .068 | .406 |
| 9 | .097 | .485 | .084 | .434 |
| 10 | .115 | .516 | .100 | .461 |
| 11 | .135 | .545 | .117 | .489 |
| 12 | .156 | .574 | .134 | .515 |
| 13 | .177 | .602 | .153 | .541 |
| 14 | .198 | .629 | .171 | .566 |
| 15 | .222 | .655 | .191 | .589 |
| 16 | .245 | .681 | .211 | .614 |
| 17 | .269 | .706 | .231 | .638 |
| 18 | .294 | .731 | .252 | .661 |
| 19 | .319 | .755 | .273 | .683 |
| 20 | .345 | .778 | .295 | .705 |
| 21 | .371 | .802 | .317 | .727 |
| 22 | .398 | .823 | .339 | .748 |
| 23 | .426 | .844 | .362 | .769 |
| 24 | .455 | .865 | .386 | .789 |
| 25 | .484 | .885 | .411 | .809 |
| 26 | .515 | .903 | .434 | .829 |
| 27 | .545 | .921 | .459 | .847 |
| 28 | .578 | .938 | .485 | .866 |
| 29 | .611 | .954 | .511 | .883 |
| 30 | .646 | .968 | .539 | .900 |
| 31 | .682 | .980 | .566 | .916 |
| 32 | .720 | .990 | .594 | .932 |
| 33 | .761 | .997 | .624 | .946 |
| 34 | .806 | 1.000 | .654 | .960 |
| 35 | .860 | 1.000 | .685 | .972 |
| 36 | | | .717 | .983 |
| 37 | | | .751 | .991 |
| 38 | | | .788 | .997 |
| 39 | | | .828 | 1.000 |
| 40 | | | .876 | 1.000 |

Appendix 3B

Table 2 (continued)

| x \ n | 45 | | 50 | |
|---|---|---|---|---|
| 0 | .000 | .111 | .000 | .101 |
| 1 | .000 | .154 | .000 | .139 |
| 2 | .002 | .190 | .002 | .173 |
| 3 | .008 | .223 | .007 | .203 |
| 4 | .015 | .254 | .014 | .231 |
| 5 | .025 | .284 | .022 | .258 |
| 6 | .036 | .312 | .032 | .285 |
| 7 | .047 | .339 | .042 | .309 |
| 8 | .060 | .366 | .054 | .334 |
| 9 | .074 | .392 | .066 | .357 |
| 10 | .088 | .418 | .079 | .381 |
| 11 | .103 | .442 | .092 | .404 |
| 12 | .118 | .465 | .106 | .425 |
| 13 | .134 | .490 | .120 | .447 |
| 14 | .150 | .513 | .134 | .469 |
| 15 | .167 | .536 | .149 | .490 |
| 16 | .184 | .558 | .164 | .511 |
| 17 | .202 | .580 | .180 | .532 |
| 18 | .221 | .601 | .196 | .551 |
| 19 | .239 | .623 | .213 | .572 |
| 20 | .257 | .644 | .229 | .591 |
| 21 | .276 | .664 | .246 | .610 |
| 22 | .296 | .684 | .263 | .629 |
| 23 | .316 | .704 | .280 | .648 |
| 24 | .336 | .724 | .298 | .666 |
| 25 | .356 | .743 | .315 | .685 |
| 26 | .377 | .761 | .334 | .702 |
| 27 | .399 | .779 | .352 | .720 |
| 28 | .420 | .798 | .371 | .737 |
| 29 | .442 | .816 | .390 | .754 |
| 30 | .464 | .833 | .409 | .771 |
| 31 | .487 | .850 | .428 | .787 |
| 32 | .510 | .866 | .449 | .804 |
| 33 | .535 | .882 | .468 | .820 |
| 34 | .558 | .897 | .489 | .836 |
| 35 | .582 | .912 | .510 | .851 |
| 36 | .608 | .926 | .531 | .866 |
| 37 | .634 | .940 | .553 | .880 |
| 38 | .661 | .953 | .575 | .894 |
| 39 | .688 | .964 | .596 | .908 |
| 40 | .716 | .975 | .619 | .921 |
| 41 | .746 | .985 | .643 | .934 |
| 42 | .777 | .992 | .666 | .946 |
| 43 | .810 | .998 | .691 | .958 |
| 44 | .846 | 1.000 | .715 | .968 |
| 45 | .889 | 1.000 | .742 | .978 |
| 46 | | | .769 | .986 |
| 47 | | | .797 | .993 |
| 48 | | | .827 | .998 |
| 49 | | | .861 | 1.000 |
| 50 | | | .899 | 1.000 |

**Example:** Observed from sample 35/50. The 99% confidence limits for the population are .510 and .851.

Appendix 3B

Table 2 (continued)

n = 60

| x | | |
|---|---|---|
| 0 | .000 | .085 |
| 1 | .000 | .117 |
| 2 | .002 | .146 |
| 3 | .006 | .172 |
| 4 | .011 | .195 |
| 5 | .018 | .218 |
| 6 | .026 | .241 |
| 7 | .035 | .263 |
| 8 | .045 | .283 |
| 9 | .055 | .304 |
| 10 | .065 | .324 |
| 11 | .076 | .343 |
| 12 | .087 | .363 |
| 13 | .098 | .381 |
| 14 | .110 | .399 |
| 15 | .123 | .418 |
| 16 | .135 | .437 |
| 17 | .148 | .454 |
| 18 | .160 | .472 |
| 19 | .174 | .489 |
| 20 | .187 | .507 |
| 21 | .201 | .524 |
| 22 | .215 | .540 |
| 23 | .228 | .557 |
| 24 | .243 | .574 |
| 25 | .257 | .590 |
| 26 | .272 | .606 |
| 27 | .286 | .622 |
| 28 | .301 | .637 |
| 29 | .316 | .654 |
| 30 | .331 | .669 |

| x | | |
|---|---|---|
| 31 | .346 | .684 |
| 32 | .363 | .699 |
| 33 | .378 | .714 |
| 34 | .394 | .728 |
| 35 | .410 | .743 |
| 36 | .426 | .757 |
| 37 | .443 | .772 |
| 38 | .460 | .785 |
| 39 | .476 | .799 |
| 40 | .493 | .813 |
| 41 | .511 | .826 |
| 42 | .528 | .840 |
| 43 | .546 | .852 |
| 44 | .563 | .865 |
| 45 | .582 | .877 |
| 46 | .601 | .890 |
| 47 | .619 | .902 |
| 48 | .637 | .913 |
| 49 | .657 | .924 |
| 50 | .676 | .935 |
| 51 | .696 | .945 |
| 52 | .717 | .955 |
| 53 | .737 | .965 |
| 54 | .759 | .974 |
| 55 | .782 | .982 |
| 56 | .805 | .989 |
| 57 | .828 | .994 |
| 58 | .854 | .998 |
| 59 | .883 | 1.000 |
| 60 | .915 | 1.000 |

Appendix 3B

Table 2 (continued)

n = 80

| x | | |
|---|---|---|
| 0 | .000 | .064 |
| 1 | .000 | .089 |
| 2 | .001 | .111 |
| 3 | .004 | .131 |
| 4 | .009 | .149 |
| 5 | .014 | .167 |
| 6 | .020 | .184 |
| 7 | .026 | .201 |
| 8 | .033 | .217 |
| 9 | .040 | .233 |
| 10 | .048 | .249 |
| 11 | .056 | .264 |
| 12 | .064 | .280 |
| 13 | .073 | .295 |
| 14 | .082 | .309 |
| 15 | .090 | .323 |
| 16 | .099 | .338 |
| 17 | .109 | .352 |
| 18 | .118 | .366 |
| 19 | .128 | .379 |
| 20 | .137 | .394 |
| 21 | .147 | .407 |
| 22 | .156 | .421 |
| 23 | .167 | .434 |
| 24 | .178 | .447 |
| 25 | .188 | .461 |

| x | | |
|---|---|---|
| 26 | .198 | .474 |
| 27 | .208 | .486 |
| 28 | .219 | .500 |
| 29 | .230 | .513 |
| 30 | .241 | .525 |
| 31 | .251 | .538 |
| 32 | .262 | .550 |
| 33 | .273 | .561 |
| 34 | .284 | .574 |
| 35 | .296 | .587 |
| 36 | .307 | .598 |
| 37 | .318 | .611 |
| 38 | .331 | .623 |
| 39 | .342 | .635 |
| 40 | .354 | .646 |
| 41 | .365 | .658 |
| 42 | .377 | .669 |
| 43 | .389 | .682 |
| 44 | .402 | .693 |
| 45 | .413 | .704 |
| 46 | .426 | .716 |
| 47 | .439 | .727 |
| 48 | .450 | .738 |
| 49 | .462 | .749 |
| 50 | .475 | .759 |
| 51 | .487 | .770 |
| 52 | .500 | .781 |
| 53 | .514 | .792 |
| 54 | .526 | .802 |
| 55 | .539 | .812 |

| x | | |
|---|---|---|
| 56 | .553 | .822 |
| 57 | .566 | .833 |
| 58 | .579 | .844 |
| 59 | .593 | .853 |
| 60 | .606 | .863 |
| 61 | .621 | .872 |
| 62 | .634 | .882 |
| 63 | .648 | .891 |
| 64 | .662 | .901 |
| 65 | .677 | .910 |
| 66 | .691 | .918 |
| 67 | .705 | .927 |
| 68 | .720 | .936 |
| 69 | .736 | .944 |
| 70 | .751 | .952 |
| 71 | .767 | .960 |
| 72 | .783 | .967 |
| 73 | .799 | .974 |
| 74 | .816 | .980 |
| 75 | .833 | .986 |
| 76 | .851 | .991 |
| 77 | .869 | .996 |
| 78 | .889 | .999 |
| 79 | .911 | 1.000 |
| 80 | .936 | 1.000 |

**Example:** Observed from sample 50/80. The 99% confidence limits for the population are .475 and .759.

Appendix 3B

Table 2 (continued)

n = 100

| x | | |
|---|---|---|
| 0 | .000 | .052 |
| 1 | .000 | .072 |
| 2 | .001 | .089 |
| 3 | .003 | .105 |
| 4 | .007 | .120 |
| 5 | .011 | .135 |
| 6 | .016 | .149 |
| 7 | .021 | .163 |
| 8 | .026 | .176 |
| 9 | .032 | .189 |
| 10 | .038 | .202 |
| 11 | .044 | .214 |
| 12 | .051 | .227 |
| 13 | .058 | .240 |
| 14 | .065 | .251 |
| 15 | .072 | .263 |
| 16 | .079 | .275 |
| 17 | .086 | .286 |
| 18 | .093 | .298 |
| 19 | .101 | .310 |
| 20 | .109 | .321 |
| 21 | .116 | .333 |
| 22 | .124 | .344 |
| 23 | .132 | .356 |
| 24 | .140 | .367 |
| 25 | .148 | .378 |
| 26 | .156 | .388 |
| 27 | .164 | .399 |
| 28 | .172 | .409 |
| 29 | .180 | .419 |
| 30 | .189 | .431 |
| 31 | .197 | .441 |
| 32 | .206 | .452 |
| 33 | .214 | .462 |
| 34 | .223 | .473 |
| 35 | .232 | .482 |
| 36 | .240 | .493 |
| 37 | .249 | .503 |
| 38 | .259 | .514 |
| 39 | .268 | .523 |
| 40 | .276 | .534 |
| 41 | .286 | .543 |
| 42 | .294 | .553 |
| 43 | .304 | .563 |
| 44 | .312 | .573 |
| 45 | .322 | .583 |
| 46 | .331 | .592 |
| 47 | .341 | .602 |
| 48 | .350 | .611 |
| 49 | .359 | .622 |
| 50 | .369 | .631 |
| 51 | .378 | .641 |
| 52 | .389 | .650 |
| 53 | .398 | .659 |
| 54 | .408 | .669 |
| 55 | .417 | .678 |
| 56 | .427 | .688 |
| 57 | .437 | .696 |
| 58 | .447 | .706 |
| 59 | .457 | .714 |
| 60 | .466 | .724 |
| 61 | .477 | .732 |
| 62 | .486 | .741 |
| 63 | .497 | .751 |
| 64 | .507 | .760 |
| 65 | .518 | .768 |
| 66 | .527 | .777 |
| 67 | .538 | .786 |
| 68 | .548 | .794 |
| 69 | .559 | .803 |
| 70 | .569 | .811 |
| 71 | .581 | .820 |
| 72 | .591 | .828 |
| 73 | .601 | .836 |
| 74 | .612 | .844 |
| 75 | .622 | .852 |
| 76 | .633 | .860 |
| 77 | .644 | .868 |
| 78 | .656 | .876 |
| 79 | .667 | .884 |
| 80 | .679 | .891 |
| 81 | .690 | .899 |
| 82 | .702 | .907 |
| 83 | .714 | .914 |
| 84 | .725 | .921 |
| 85 | .737 | .928 |
| 86 | .749 | .935 |
| 87 | .760 | .942 |
| 88 | .773 | .949 |
| 89 | .786 | .956 |
| 90 | .798 | .962 |
| 91 | .811 | .968 |
| 92 | .824 | .974 |
| 93 | .837 | .979 |
| 94 | .851 | .984 |
| 95 | .865 | .989 |
| 96 | .880 | .993 |
| 97 | .895 | .997 |
| 98 | .911 | .999 |
| 99 | .928 | 1.000 |
| 100 | .948 | 1.000 |

Example: Observed from sample 50/100. The 99% confidence limits for the population are .369 and .631.

Table 3

Confidence in Inferring (90% < p) for Binomial Distribution

The following tables list the confidence value in the body of the table in inferring that 90% < p for a binomial distribution.

These tables are useful for answering such questions as "i? (x) units out of a sample of size (n) are observed to have some particular attribute, what confidence can be put in the statement that the true proportion of the population having this attribute is greater than 90%."

If the above question is asked about many different situations, then the table entry lists the percentage of situations in which p is actually greater than 90%.

Thus, the tables list for each sample size, n, and each observed number, x, a value for P such that

$$P\ (90\% < p) = \text{table entry}$$

Examples are given on each table.

PERCENTAGE CONFIDENCE IN INFERRING 90%≤p≤100%

| x \ n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1 | 10 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 2 | | 19 | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 3 | | | 27 | 5 | <1 | <1 | <1 | <1 | <1 | <1 |
| 4 | | | | 34 | 8 | 2 | <1 | <1 | <1 | <1 |
| 5 | | | | | 41 | 11 | 3 | <1 | <1 | <1 |
| 6 | | | | | | 47 | 15 | 4 | <1 | <1 |
| 7 | | | | | | | 52 | 19 | 5 | 1 |
| 8 | | | | | | | | 57 | 23 | 7 |
| 9 | | | | | | | | | 61 | 26 |
| 10 | | | | | | | | | | 65 |

Appendix 3B

Table 3 (Continued)

| x \ n | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 8 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 9 | 9 | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 10 | 30 | 11 | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 11 | 69 | 34 | 13 | 4 | 1 | <1 | <1 | <1 | <1 | <1 |
| 12 | | 72 | 38 | 16 | 6 | 2 | <1 | <1 | <1 | <1 |
| 13 | | | 75 | 42 | 18 | 7 | 2 | <1 | <1 | <1 |
| 14 | | | | 77 | 45 | 21 | 8 | 3 | <1 | <1 |
| 15 | | | | | 79 | 49 | 24 | 10 | 4 | 1 |
| 16 | | | | | | 81 | 52 | 27 | 11 | 4 |
| 17 | | | | | | | 83 | 55 | 29 | 13 |
| 18 | | | | | | | | 85 | 58 | 32 |
| 19 | | | | | | | | | 86 | 61 |
| 20 | | | | | | | | | | 88 |

**Example:** Observed from sample 16/17
Confidence in inferring $90\% \leq p \leq 100\%$ is 52%

Appendix 3B

Table 3 (Continued)

| x \ n | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤15 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 16 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 17 | 5 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 18 | 15 | 6 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 19 | 35 | 17 | 7 | 3 | <1 | <1 | <1 | <1 | <1 | <1 |
| 20 | 64 | 38 | 19 | 9 | 3 | 1 | <1 | <1 | <1 | <1 |
| 21 | 89 | 66 | 41 | 21 | 10 | 4 | 1 | <1 | <1 | <1 |
| 22 | | 90 | 68 | 44 | 24 | 11 | 5 | 2 | <1 | <1 |
| 23 | | | 91 | 71 | 46 | 26 | 13 | 6 | 2 | <1 |
| 24 | | | | 92 | 73 | 49 | 28 | 14 | 6 | 3 |
| 25 | | | | | 93 | 75 | 52 | 31 | 16 | 7 |
| 26 | | | | | | 94 | 77 | 54 | 33 | 18 |
| 27 | | | | | | | 94 | 78 | 57 | 35 |
| 28 | | | | | | | | 95 | 80 | 59 |
| 29 | | | | | | | | | 95 | 82 |
| 30 | | | | | | | | | | 96 |

**Example:** Observed from sample 21/24
Confidence in inferring $90\% \leq p \leq 100\%$ is 21%

Appendix 3B

Table 3 (Continued)

| x \ n | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤23 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 24 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 25 | 3 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 26 | 8 | 4 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 27 | 19 | 9 | 4 | 2 | 1 | <1 | <1 | <1 | <1 | <1 |
| 28 | 38 | 21 | 11 | 5 | 2 | <1 | <1 | <1 | <1 | <1 |
| 29 | 61 | 40 | 23 | 12 | 6 | 2 | <1 | <1 | <1 | <1 |
| 30 | 83 | 63 | 42 | 25 | 13 | 6 | 3 | 1 | <1 | <1 |
| 31 | 96 | 84 | 65 | 45 | 27 | 15 | 7 | 3 | 1 | <1 |
| 32 | | 97 | 86 | 67 | 47 | 29 | 16 | 8 | 4 | 2 |
| 33 | | | 97 | 87 | 69 | 49 | 31 | 17 | 9 | 4 |
| 34 | | | | 97 | 88 | 71 | 51 | 33 | 19 | 10 |
| 35 | | | | | 97 | 89 | 73 | 54 | 35 | 21 |
| 36 | | | | | | 98 | 90 | 75 | 56 | 37 |
| 37 | | | | | | | 98 | 90 | 76 | 58 |
| 38 | | | | | | | | 98 | 91 | 78 |
| 39 | | | | | | | | | 98 | 92 |
| 40 | | | | | | | | | | 99 |

**Example:** Observed from sample 34/36
Confidence in inferring 90% ≤ p ≤ 100% is 71%

Appendix 3B

Table 3 (Continued)

| x \ n | 45 | 50 |
|---|---|---|
| ≤ 35 | <1 | <1 |
| 36 | 1 | <1 |
| 37 | 3 | <1 |
| 38 | 8 | <1 |
| 39 | 16 | <1 |
| 40 | 29 | 2 |
| 41 | 47 | 6 |
| 42 | 67 | 12 |
| 43 | 84 | 23 |
| 44 | 95 | 33 |
| 45 | 99 | 38 |
| 46 | | 57 |
| 47 | | 75 |
| 48 | | 89 |
| 49 | | 97 |
| 50 | | >99 |

| x \ n | 55 | 60 |
|---|---|---|
| ≤44 | <1 | <1 |
| 45 | 2 | <1 |
| 46 | 4 | <1 |
| 47 | 9 | <1 |
| 48 | 18 | <1 |
| 49 | 31 | 1 |
| 50 | 48 | 3 |
| 51 | 65 | 7 |
| 52 | 81 | 14 |
| 53 | 92 | 25 |
| 54 | 98 | 39 |
| 55 | >99 | 56 |
| 56 | | 73 |
| 57 | | 86 |
| 58 | | 94 |
| 59 | | 99 |
| 60 | | >99 |

| x \ n | 65 | 70 |
|---|---|---|
| ≤52 | <1 | <1 |
| 53 | 1 | <1 |
| 54 | 3 | <1 |
| 55 | 6 | <1 |
| 56 | 11 | <1 |
| 57 | 20 | <1 |
| 58 | 32 | 2 |
| 59 | 48 | 4 |
| 60 | 64 | 9 |
| 61 | 79 | 16 |
| 62 | 90 | 26 |
| 63 | 96 | 40 |
| 64 | 99 | 56 |
| 65 | >99 | 71 |
| 66 | | 84 |
| 67 | | 93 |
| 68 | | 98 |
| 69 | | >99 |
| 70 | | >99 |

Appendix 3B

Table 3 (Continued)

| x \ n | 75 | 80 |
|---|---|---|
| ≤61 | <1 | <1 |
| 62 | 2 | <1 |
| 63 | 4 | <1 |
| 64 | 7 | <1 |
| 65 | 13 | <1 |
| 66 | 21 | 1 |
| 67 | 33 | 3 |
| 68 | 48 | 5 |
| 69 | 63 | 10 |
| 70 | 77 | 17 |
| 71 | 88 | 28 |
| 72 | 95 | 41 |
| 73 | 98 | 55 |
| 74 | >99 | 70 |
| 75 | >99 | 82 |
| 76 | | 91 |
| 77 | | 96 |
| 78 | | 99 |
| 79 | | >99 |
| 80 | | >99 |

| x \ n | 85 | 90 |
|---|---|---|
| ≤69 | <1 | <1 |
| 70 | 1 | <1 |
| 71 | 2 | <1 |
| 72 | 4 | <1 |
| 73 | 8 | <1 |
| 74 | 14 | <1 |
| 75 | 23 | 2 |
| 76 | 34 | 3 |
| 77 | 48 | 6 |
| 78 | 62 | 11 |
| 79 | 76 | 19 |
| 80 | 86 | 29 |
| 81 | 94 | 41 |
| 82 | 98 | 55 |
| 83 | 99 | 69 |
| 84 | >99 | 81 |
| 85 | >99 | 90 |
| 86 | | 95 |
| 87 | | 98 |
| 88 | | >99 |
| 89 | | >99 |
| 90 | | >99 |

| x \ n | 95 | 100 |
|---|---|---|
| ≤78 | <1 | <1 |
| 79 | 1 | <1 |
| 80 | 3 | <1 |
| 81 | 5 | <1 |
| 82 | 9 | <1 |
| 83 | 15 | 1 |
| 84 | 24 | 2 |
| 85 | 35 | 4 |
| 86 | 48 | 7 |
| 87 | 62 | 12 |
| 88 | 75 | 20 |
| 89 | 85 | 30 |
| 90 | 92 | 42 |
| 91 | 97 | 55 |
| 92 | 99 | 68 |
| 93 | >99 | 79 |
| 94 | >99 | 88 |
| 95 | >99 | 94 |
| 96 | | 98 |
| 97 | | 99 |
| 98 | | >99 |
| 99 | | >99 |
| 100 | | >99 |

**Example:** Observed from sample 76/85
Confidence in inferring $90\% \leq p \leq 100\%$ is 34%

Appendix 3B

Table 3 (continued)

Confidence in Inferring (95% < p) for Binomial Distribution

The following tables list the confidence value in the body of the table in inferring that 95% < p for a binomial distribution.

These tables are useful for answering such questions as "if (x) units out of a sample of size (n) are observed to have some particular attribute, what confidence can be put in the statement that the true proportion of the population having this attribute is greater than 95%."

If the above question is asked about many different situations, then the table entry lists the percentage of situations in which p is actually greater than 95%.

Thus, the tables list for each sample size, n, and each observed number, x, a value for P such that

$$P(95\% < p) = \text{table entry}$$

Examples are given on each table.

| x \ n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1 | 5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 2 | | 10 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 3 | | | 14 | 1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 4 | | | | 19 | 2 | <1 | <1 | <1 | <1 | <1 |
| 5 | | | | | 23 | 3 | <1 | <1 | <1 | <1 |
| 6 | | | | | | 26 | 4 | 1 | <1 | <1 |
| 7 | | | | | | | 30 | 6 | 1 | <1 |
| 8 | | | | | | | | 34 | 7 | 1 |
| 9 | | | | | | | | | 37 | 9 |
| 10 | | | | | | | | | | 40 |

Appendix 3B

Table 3 (Continued)

| x \ n | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤8 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 9 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 10 | 10 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 11 | 43 | 12 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 12 | | 46 | 14 | 3 | 1 | <1 | <1 | <1 | <1 | <1 |
| 13 | | | 49 | 15 | 4 | 1 | <1 | <1 | <1 | <1 |
| 14 | | | | 51 | 17 | 4 | 1 | <1 | <1 | <1 |
| 15 | | | | | 54 | 19 | 5 | 1 | <1 | <1 |
| 16 | | | | | | 56 | 21 | 6 | 1 | <1 |
| 17 | | | | | | | 58 | 23 | 7 | 2 |
| 18 | | | | | | | | 60 | 25 | 8 |
| 19 | | | | | | | | | 62 | 26 |
| 20 | | | | | | | | | | 64 |

Example: Observed from sample 14/15
Confidence in inferring 95% ≤ p ≤ 100% is 17%

| x \ n | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤17 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 18 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 19 | 8 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 20 | 28 | 9 | 3 | 1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 21 | 66 | 30 | 11 | 3 | 1 | <1 | <1 | <1 | <1 | <1 |
| 22 | | 67 | 32 | 12 | 3 | <1 | <1 | <1 | <1 | <1 |
| 23 | | | 69 | 34 | 13 | 4 | 1 | <1 | <1 | <1 |
| 24 | | | | 71 | 36 | 14 | 4 | 1 | <1 | <1 |
| 25 | | | | | 72 | 38 | 15 | 5 | 1 | <1 |
| 26 | | | | | | 74 | 39 | 16 | 5 | 2 |
| 27 | | | | | | | 75 | 41 | 18 | 6 |
| 28 | | | | | | | | 76 | 43 | 19 |
| 29 | | | | | | | | | 77 | 45 |
| 30 | | | | | | | | | | 79 |

Appendix 3B

Table 3 (Continued)

| x \ n | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤26 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 27 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 28 | 7 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 29 | 20 | 7 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 30 | 46 | 21 | 8 | 3 | <1 | <1 | <1 | <1 | <1 | <1 |
| 31 | 80 | 48 | 23 | 9 | 3 | <1 | <1 | <1 | <1 | <1 |
| 32 | | 81 | 50 | 24 | 10 | 3 | 1 | <1 | <1 | <1 |
| 33 | | | 82 | 51 | 25 | 10 | 4 | 1 | <1 | <1 |
| 34 | | | | 83 | 53 | 27 | 11 | 4 | 1 | <1 |
| 35 | | | | | 83 | 54 | 28 | 12 | 4 | 1 |
| 36 | | | | | | 84 | 56 | 30 | 13 | 5 |
| 37 | | | | | | | 85 | 57 | 31 | 14 |
| 38 | | | | | | | | 86 | 59 | 32 |
| 39 | | | | | | | | | 86 | 60 |
| 40 | | | | | | | | | | 87 |

Example: Observed from sample 26/29
Confidence in inferring 95% ≤ p ≤ 100% is 5%

| x \ n | 45 | 50 |
|---|---|---|
| ≤38 | <1 | <1 |
| 39 | 1 | <1 |
| 40 | 2 | <1 |
| 41 | 7 | <1 |
| 42 | 19 | <1 |
| 43 | 39 | <1 |
| 44 | 67 | 1 |
| 45 | 90 | 4 |
| 46 | | 10 |
| 47 | | 24 |
| 48 | | 46 |
| 49 | | 72 |
| 50 | | 92 |

| x \ n | 55 | 60 |
|---|---|---|
| ≤47 | <1 | <1 |
| 48 | 1 | <1 |
| 49 | 2 | <1 |
| 50 | 6 | <1 |
| 51 | 14 | <1 |
| 52 | 30 | <1 |
| 53 | 52 | 1 |
| 54 | 77 | 3 |
| 55 | 94 | 8 |
| 56 | | 18 |
| 57 | | 35 |
| 58 | | 58 |
| 59 | | 81 |
| 60 | | 95 |

| x \ n | 65 | 70 |
|---|---|---|
| ≤57 | <1 | <1 |
| 58 | 2 | <1 |
| 59 | 4 | <1 |
| 60 | 11 | <1 |
| 61 | 22 | <1 |
| 62 | 41 | 1 |
| 63 | 64 | 2 |
| 64 | 84 | 6 |
| 65 | 96 | 14 |
| 66 | | 27 |
| 67 | | 47 |
| 68 | | 69 |
| 69 | | 87 |
| 70 | | 97 |

Appendix 3B

Table 3 (Continued)

| x \ n | 75 | 80 |
|---|---|---|
| ≤66 | <1 | <1 |
| 67 | 1 | <1 |
| 68 | 3 | <1 |
| 69 | 8 | <1 |
| 70 | 17 | <1 |
| 71 | 32 | <1 |
| 72 | 52 | 1 |
| 73 | 73 | 4 |
| 74 | 89 | 10 |
| 75 | 98 | 21 |
| 76 | | 37 |
| 77 | | 57 |
| 78 | | 77 |
| 79 | | 91 |
| 80 | | 98 |

| x \ n | 85 | 90 |
|---|---|---|
| ≤76 | <1 | <1 |
| 77 | 3 | <1 |
| 78 | 6 | <1 |
| 79 | 13 | <1 |
| 80 | 25 | <1 |
| 81 | 42 | 1 |
| 82 | 62 | 4 |
| 83 | 80 | 8 |
| 84 | 93 | 16 |
| 85 | 99 | 29 |
| 86 | | 47 |
| 87 | | 66 |
| 88 | | 83 |
| 89 | | 94 |
| 90 | | 99 |

| x \ n | 95 | 100 |
|---|---|---|
| ≤85 | <1 | <1 |
| 86 | 2 | <1 |
| 87 | 5 | <1 |
| 88 | 10 | <1 |
| 89 | 20 | <1 |
| 90 | 34 | 1 |
| 91 | 52 | 3 |
| 92 | 71 | 6 |
| 93 | 86 | 13 |
| 94 | 95 | 23 |
| 95 | 99 | 38 |
| 96 | | 56 |
| 97 | | 74 |
| 98 | | 88 |
| 99 | | 96 |
| 100 | | 99 |

Example: Observed from sample 90/90
Confidence in inferring 95% $\leq p \leq$ 100% is 99%

Appendix 3B

Table 3 (Continued)

Confidence in Inferring (97% < p) for Binomial Distribution

The following tables list the confidence value in the body of the table in inferring that 97% < p for a binomial distribution.

These tables are useful for answering such questions as "if x units out of a sample of size n are observed to have some particular attribute, what confidence can be put in the statement that the true proportion of the population having this attribute is greater than 97%."

If the above question is asked about many different situations, then the table entry lists the percentage of situations in which p is actually greater the 97%.

Thus, the tables list for each sample size, n, and each observed number, x, a value for P such that

$$P\ (97\% < p) = \text{table entry.}$$

Examples are given on each table.

| x \ n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1 | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 2 | | 6 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 3 | | | 9 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 4 | | | | 11 | <1 | <1 | <1 | <1 | <1 | <1 |
| 5 | | | | | 14 | <1 | <1 | <1 | <1 | <1 |
| 6 | | | | | | 17 | 2 | <1 | <1 | <1 |
| 7 | | | | | | | 19 | 2 | <1 | <1 |
| 8 | | | | | | | | 22 | 3 | <1 |
| 9 | | | | | | | | | 24 | 3 |
| 10 | | | | | | | | | | 26 |

Appendix 3B

Table 3 (Continued)

| x \ n | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤9 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 10 | 4 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 11 | 28 | 5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 12 | | 31 | 6 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 13 | | | 33 | 6 | <1 | <1 | <1 | <1 | <1 | <1 |
| 14 | | | | 35 | 7 | <1 | <1 | <1 | <1 | <1 |
| 15 | | | | | 37 | 8 | 1 | <1 | <1 | <1 |
| 16 | | | | | | 39 | 9 | 2 | <1 | <1 |
| 17 | | | | | | | 40 | 10 | 2 | <1 |
| 18 | | | | | | | | 42 | 11 | 2 |
| 19 | | | | | | | | | 44 | 12 |
| 20 | | | | | | | | | | 46 |

**Example:** Observed from sample 19/20
Confidence in inferring 97% ≤ p ≤ 100% is 12%

| x \ n | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤18 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 19 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 20 | 13 | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 21 | 47 | 14 | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 22 | | 49 | 15 | 3 | <1 | <1 | <1 | <1 | <1 | <1 |
| 23 | | | 50 | 16 | 4 | <1 | <1 | <1 | <1 | <1 |
| 24 | | | | 52 | 17 | 4 | <1 | <1 | <1 | <1 |
| 25 | | | | | 53 | 18 | 5 | <1 | <1 | <1 |
| 26 | | | | | | 55 | 19 | 5 | 1 | <1 |
| 27 | | | | | | | 56 | 20 | 6 | 1 |
| 28 | | | | | | | | 57 | 22 | 6 |
| 29 | | | | | | | | | 59 | 23 |
| 30 | | | | | | | | | | 60 |

Table 3 (Continued)

| x \ n | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤27 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 28 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 29 | 7 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 30 | 24 | 7 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 31 | 61 | 25 | 8 | 2 | <1 | <1 | <1 | <1 | <1 | <1 |
| 32 | | 62 | 26 | 8 | 2 | <1 | <1 | <1 | <1 | <1 |
| 33 | | | 63 | 27 | 9 | <1 | <1 | <1 | <1 | <1 |
| 34 | | | | 64 | 28 | 9 | 2 | <1 | <1 | <1 |
| 35 | | | | | 66 | 29 | 10 | 3 | <1 | <1 |
| 36 | | | | | | 67 | 31 | 11 | 3 | <1 |
| 37 | | | | | | | 68 | 32 | 11 | 3 |
| 38 | | | | | | | | 69 | 33 | 12 |
| 39 | | | | | | | | | 70 | 34 |
| 40 | | | | | | | | | | 70 |

Example: Observed from sample 35/36
Confidence in inferring 97% ≤p ≤100% is 29%

| x \ n | 45 | 50 |
|---|---|---|
| ≤40 | <1 | <1 |
| 41 | 1 | <1 |
| 42 | 5 | <1 |
| 43 | 15 | <1 |
| 44 | 39 | <1 |
| 45 | 75 | <1 |
| 46 | | 2 |
| 47 | | 6 |
| 48 | | 19 |
| 49 | | 44 |
| 50 | | 78 |

| x \ n | 55 | 60 |
|---|---|---|
| ≤50 | <1 | <1 |
| 51 | 2 | <1 |
| 52 | 8 | <1 |
| 53 | 23 | <1 |
| 54 | 49 | <1 |
| 55 | 81 | <1 |
| 56 | | 3 |
| 57 | | 11 |
| 58 | | 27 |
| 59 | | 54 |
| 60 | | 84 |

| x \ n | 65 | 70 |
|---|---|---|
| ≤59 | <1 | <1 |
| 60 | 1 | <1 |
| 61 | 5 | <1 |
| 62 | 13 | <1 |
| 63 | 31 | <1 |
| 64 | 58 | <1 |
| 65 | 86 | 2 |
| 66 | | 6 |
| 67 | | 16 |
| 68 | | 35 |
| 69 | | 62 |
| 70 | | 88 |

Appendix 3B

Table 3 (Continued)

| x \ n | 75 | 80 |
|---|---|---|
| ≤69 | <1 | <1 |
| 70 | 3 | <1 |
| 71 | 8 | <1 |
| 72 | 19 | <1 |
| 73 | 39 | <1 |
| 74 | 66 | 1 |
| 75 | 90 | 3 |
| 76 | | 9 |
| 77 | | 22 |
| 78 | | 43 |
| 79 | | 70 |
| 80 | | 91 |

| x \ n | 85 | 90 |
|---|---|---|
| ≤78 | <1 | <1 |
| 79 | 1 | <1 |
| 80 | 4 | <1 |
| 81 | 11 | <1 |
| 82 | 25 | <1 |
| 83 | 47 | <1 |
| 84 | 73 | 2 |
| 85 | 92 | 5 |
| 86 | | 13 |
| 87 | | 28 |
| 88 | | 51 |
| 89 | | 76 |
| 90 | | 94 |

| x \ n | 95 | 100 |
|---|---|---|
| ≤88 | <1 | <1 |
| 89 | 2 | <1 |
| 90 | 7 | <1 |
| 91 | 16 | <1 |
| 92 | 32 | <1 |
| 93 | 55 | 1 |
| 94 | 78 | 3 |
| 95 | 94 | 8 |
| 96 | | 18 |
| 97 | | 35 |
| 98 | | 58 |
| 99 | | 81 |
| 100 | | 95 |

**Example:** Observed from sample 93/95
Confidence in inferring 97% ≤ p ≤ 100% is 55%

Appendix 3B

Table 3 (Continued)

| x \ n | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤27 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 28 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 29 | 7 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 30 | 24 | 7 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 31 | 61 | 25 | 8 | 2 | <1 | <1 | <1 | <1 | <1 | <1 |
| 32 | | 62 | 26 | 8 | 2 | <1 | <1 | <1 | <1 | <1 |
| 33 | | | 63 | 27 | 9 | <1 | <1 | <1 | <1 | <1 |
| 34 | | | | 64 | 28 | 9 | 2 | <1 | <1 | <1 |
| 35 | | | | | 66 | 29 | 10 | 3 | <1 | <1 |
| 36 | | | | | | 67 | 31 | 11 | 3 | <1 |
| 37 | | | | | | | 68 | 32 | 11 | 3 |
| 38 | | | | | | | | 69 | 33 | 12 |
| 39 | | | | | | | | | 70 | 34 |
| 40 | | | | | | | | | | 70 |

Example: Observed from sample 35/36
Confidence in inferring 97% ≤ p ≤ 100% is 29%

| x \ n | 45 | 50 |
|---|---|---|
| ≤40 | <1 | <1 |
| 41 | 1 | <1 |
| 42 | 5 | <1 |
| 43 | 15 | <1 |
| 44 | 39 | <1 |
| 45 | 75 | <1 |
| 46 | | 2 |
| 47 | | 6 |
| 48 | | 19 |
| 49 | | 44 |
| 50 | | 78 |

| x \ n | 55 | 60 |
|---|---|---|
| ≤50 | <1 | <1 |
| 51 | 2 | <1 |
| 52 | 8 | <1 |
| 53 | 23 | <1 |
| 54 | 49 | <1 |
| 55 | 81 | <1 |
| 56 | | 3 |
| 57 | | 11 |
| 58 | | 27 |
| 59 | | 54 |
| 60 | | 84 |

| x \ n | 65 | 70 |
|---|---|---|
| ≤59 | <1 | <1 |
| 60 | 1 | <1 |
| 61 | 5 | <1 |
| 62 | 13 | <1 |
| 63 | 31 | <1 |
| 64 | 58 | <1 |
| 65 | 86 | 2 |
| 66 | | 6 |
| 67 | | 16 |
| 68 | | 35 |
| 69 | | 62 |
| 70 | | 88 |

Appendix 3B

Table 3 (continued)

Confidence in Inferring (99%< p) for Binomial Distribution

The following tables list the confidence value in the body of the table in inferring that 99%< p for a binomial distribution.

These tables are useful for answering such questions as "if (x) units out of a sample of size (n) are observed to have some particular attribute, what confidence can be put in the statement that the true proportion of the population having this attribute is greater than 99%."

If the above question is asked about many different situations, then the table entry lists the percentage of situations in which p is acutally greater than 99%.

Thus, the tables list for each sample size, n, and each observed number, x, a value for P such that

$$P\ (99\% < p) = \text{table entry}$$

Examples are given on each table.

| x \ n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 2 | | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 3 | | | 3 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 4 | | | | 4 | <1 | <1 | <1 | <1 | <1 | <1 |
| 5 | | | | | 5 | <1 | <1 | <1 | <1 | <1 |
| 6 | | | | | | 6 | <1 | <1 | <1 | <1 |
| 7 | | | | | | | 7 | <1 | <1 | <1 |
| 8 | | | | | | | | 8 | <1 | <1 |
| 9 | | | | | | | | | 9 | <1 |
| 10 | | | | | | | | | | 10 |

Appendix 3B

Table 3 (Continued)

| x \ n | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤10 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 11 | 10 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 12 | | 11 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 13 | | | 12 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 14 | | | | 13 | 1 | <1 | <1 | <1 | <1 | <1 |
| 15 | | | | | 14 | 1 | <1 | <1 | <1 | <1 |
| 16 | | | | | | 15 | 1 | <1 | <1 | <1 |
| 17 | | | | | | | 16 | 1 | <1 | <1 |
| 18 | | | | | | | | 17 | 2 | <1 |
| 19 | | | | | | | | | 17 | 2 |
| 20 | | | | | | | | | | 18 |

Example: Observed from sample 16/16
Confidence in inferring 99% ≤ p ≤ 100% is 15%

| x \ n | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤19 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 20 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 21 | 19 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 22 | | 20 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 23 | | | 21 | 2 | <1 | <1 | <1 | <1 | <1 | <1 |
| 24 | | | | 21 | 3 | <1 | <1 | <1 | <1 | <1 |
| 25 | | | | | 22 | 3 | <1 | <1 | <1 | <1 |
| 26 | | | | | | 23 | 3 | <1 | <1 | <1 |
| 27 | | | | | | | 24 | 3 | <1 | <1 |
| 28 | | | | | | | | 24 | 3 | <1 |
| 29 | | | | | | | | | 25 | 4 |
| 30 | | | | | | | | | | 26 |

Appendix 3B

Table 3 (Continued)

| x \ n | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤29 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 30 | 4 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 31 | 27 | 4 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 32 | | 28 | 4 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 33 | | | 28 | 5 | <1 | <1 | <1 | <1 | <1 | <1 |
| 34 | | | | 29 | 5 | <1 | <1 | <1 | <1 | <1 |
| 35 | | | | | 30 | 5 | <1 | <1 | <1 | <1 |
| 36 | | | | | | 30 | 5 | <1 | <1 | <1 |
| 37 | | | | | | | 31 | 6 | <1 | <1 |
| 38 | | | | | | | | 32 | 6 | <1 |
| 39 | | | | | | | | | 32 | 6 |
| 40 | | | | | | | | | | 33 |

Example: Observed from sample 27/ 28
Confidence in inferring 99% ≤ p ≤ 100% is 3%

| x \ n | 45 | 50 |
|---|---|---|
| ≤42 | <1 | <1 |
| 43 | 1 | <1 |
| 44 | 7 | <1 |
| 45 | 36 | <1 |
| 46 | | <1 |
| 47 | | <1 |
| 48 | | 1 |
| 49 | | 9 |
| 50 | | 39 |

| x \ n | 55 | 60 |
|---|---|---|
| ≤52 | <1 | <1 |
| 53 | 2 | <1 |
| 54 | 11 | <1 |
| 55 | 42 | <1 |
| 56 | | <1 |
| 57 | | <1 |
| 58 | | 2 |
| 59 | | 12 |
| 60 | | 45 |

| x \ n | 65 | 70 |
|---|---|---|
| ≤62 | <1 | <1 |
| 63 | 3 | <1 |
| 64 | 14 | <1 |
| 65 | 48 | <1 |
| 66 | | <1 |
| 67 | | <1 |
| 68 | | 3 |
| 69 | | 16 |
| 70 | | 51 |

| x \ n | 75 | 80 |
|---|---|---|
| ≤72 | <1 | <1 |
| 73 | 4 | <1 |
| 74 | 17 | <1 |
| 75 | 53 | <1 |
| 76 | | <1 |
| 77 | | <1 |
| 78 | | 5 |
| 79 | | 19 |
| 80 | | 55 |

Appendix 3B

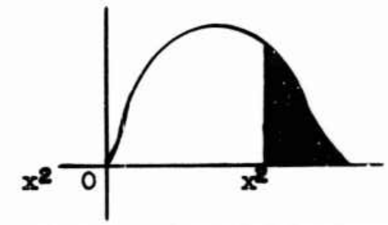
Table 3 (Continued)

| x \ n | 85 | 90 |
|---|---|---|
| ≤81 | <1 | <1 |
| 82 | 1 | <1 |
| 83 | 5 | <1 |
| 84 | 21 | <1 |
| 85 | 57 | <1 |
| 86 | | <1 |
| 87 | | 1 |
| 88 | | 6 |
| 89 | | 23 |
| 90 | | 60 |

| x \ n | 95 | 100 |
|---|---|---|
| ≤91 | <1 | <1 |
| 92 | 2 | <1 |
| 93 | 7 | <1 |
| 94 | 25 | <1 |
| 95 | 62 | <1 |
| 96 | | <1 |
| 97 | | 2 |
| 98 | | 8 |
| 99 | | 26 |
| 100 | | 63 |

Example: Observed from sample 74/75
Confidence in inferring 99% ≤ p ≤ 100% is 17%

## Appendix 3C




### Chi-Square Distribution

| Degrees of Freedom | P = 0.99 | 0.98 | 0.95 | 0.90 | 0.80 | 0.70 | 0.50 | 0.30 | 0.20 | 0.10 | 0.05 | 0.02 | 0.01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.000157 | 0.000628 | 0.00393 | 0.0158 | 0.0642 | 0.148 | 0.455 | 1.074 | 1.642 | 2.706 | 3.841 | 5.412 | 6.635 |
| 2 | 0.0201 | 0.0404 | 0.103 | 0.211 | 0.446 | 0.713 | 1.386 | 2.408 | 3.219 | 4.605 | 5.991 | 7.824 | 9.210 |
| 3 | 0.115 | 0.185 | 0.352 | 0.584 | 1.005 | 1.424 | 2.366 | 3.665 | 4.642 | 6.251 | 7.815 | 9.837 | 11.341 |
| 4 | 0.297 | 0.429 | 0.711 | 1.064 | 1.649 | 2.195 | 3.357 | 4.878 | 5.989 | 7.779 | 9.488 | 11.668 | 13.277 |
| 5 | 0.554 | 0.752 | 1.145 | 1.610 | 2.343 | 3.000 | 4.351 | 6.064 | 7.289 | 9.236 | 11.070 | 13.388 | 15.086 |
| 6 | 0.872 | 1.134 | 1.635 | 2.204 | 3.070 | 3.828 | 5.348 | 7.231 | 8.558 | 10.645 | 12.592 | 15.033 | 16.812 |
| 7 | 1.239 | 1.564 | 2.167 | 2.833 | 3.822 | 4.671 | 6.346 | 8.383 | 9.803 | 12.017 | 14.067 | 16.622 | 18.475 |
| 8 | 1.646 | 2.032 | 2.733 | 3.490 | 4.594 | 5.527 | 7.344 | 9.524 | 11.030 | 13.362 | 15.507 | 18.168 | 20.090 |
| 9 | 2.088 | 2.532 | 3.325 | 4.168 | 5.380 | 6.393 | 8.343 | 10.656 | 12.242 | 14.684 | 16.919 | 19.679 | 21.666 |
| 10 | 2.558 | 3.059 | 3.940 | 4.865 | 6.179 | 7.267 | 9.342 | 11.781 | 13.442 | 15.987 | 18.307 | 21.161 | 23.209 |
| 11 | 3.053 | 3.609 | 4.575 | 5.578 | 6.989 | 8.148 | 10.341 | 12.899 | 14.631 | 17.275 | 19.675 | 22.618 | 24.725 |
| 12 | 3.571 | 4.178 | 5.226 | 6.304 | 7.807 | 9.034 | 11.340 | 14.011 | 15.812 | 18.549 | 21.026 | 24.054 | 26.217 |
| 13 | 4.107 | 4.765 | 5.892 | 7.042 | 8.634 | 9.926 | 12.340 | 15.119 | 16.985 | 19.812 | 22.362 | 25.472 | 27.688 |
| 14 | 4.660 | 5.368 | 6.571 | 7.790 | 9.467 | 10.821 | 13.339 | 16.222 | 18.151 | 21.064 | 23.685 | 26.873 | 29.141 |
| 15 | 5.229 | 5.985 | 7.261 | 8.547 | 10.307 | 11.721 | 14.339 | 17.322 | 19.311 | 22.307 | 24.996 | 28.259 | 30.578 |
| 16 | 5.812 | 6.614 | 7.962 | 9.312 | 11.152 | 12.624 | 15.338 | 18.418 | 20.465 | 23.542 | 26.296 | 29.633 | 32.000 |
| 17 | 6.408 | 7.255 | 8.672 | 10.085 | 12.002 | 13.531 | 16.338 | 19.511 | 21.615 | 24.769 | 27.587 | 30.995 | 33.409 |
| 18 | 7.015 | 7.906 | 9.390 | 10.865 | 12.857 | 14.440 | 17.338 | 20.601 | 22.760 | 25.989 | 28.869 | 32.346 | 34.805 |
| 19 | 7.633 | 8.567 | 10.117 | 11.651 | 13.716 | 15.352 | 18.338 | 21.689 | 23.900 | 27.204 | 30.144 | 33.687 | 36.191 |
| 20 | 8.260 | 9.237 | 10.851 | 12.443 | 14.578 | 16.266 | 19.337 | 22.775 | 25.038 | 28.412 | 31.410 | 35.020 | 37.566 |
| 21 | 8.897 | 9.915 | 11.591 | 13.240 | 15.445 | 17.182 | 20.337 | 23.858 | 26.171 | 29.615 | 32.671 | 36.343 | 38.932 |
| 22 | 9.542 | 10.600 | 12.338 | 14.041 | 16.314 | 18.101 | 21.337 | 24.939 | 27.301 | 30.813 | 33.924 | 37.659 | 40.289 |
| 23 | 10.196 | 11.293 | 13.091 | 14.848 | 17.187 | 19.021 | 22.337 | 26.018 | 28.429 | 32.007 | 35.172 | 38.968 | 41.638 |
| 24 | 10.856 | 11.992 | 13.848 | 15.659 | 18.062 | 19.943 | 23.337 | 27.096 | 29.553 | 33.196 | 36.415 | 40.270 | 42.980 |
| 25 | 11.524 | 12.697 | 14.611 | 16.473 | 18.940 | 20.867 | 24.337 | 28.172 | 30.675 | 34.382 | 37.652 | 41.566 | 44.314 |
| 26 | 12.198 | 13.409 | 15.379 | 17.292 | 19.820 | 21.792 | 25.336 | 29.246 | 31.795 | 35.563 | 38.885 | 42.856 | 45.642 |
| 27 | 12.879 | 14.125 | 16.151 | 18.114 | [illegible] | 22.719 | 26.336 | 30.319 | 32.912 | 36.741 | 40.113 | 44.140 | 46.963 |
| 28 | 13.565 | 14.847 | 16.928 | 18.939 | 21.588 | 23.647 | 27.336 | 31.391 | 34.027 | 37.916 | 41.337 | 45.419 | 48.278 |
| 29 | 14.256 | 15.574 | 17.708 | 19.768 | 22.475 | 24.577 | 28.336 | 32.461 | 35.139 | 39.087 | 42.557 | 46.693 | 49.588 |
| 30 | 14.953 | 16.306 | 18.493 | 20.599 | 23.364 | 25.508 | 29.336 | 33.530 | 36.250 | 40.256 | 43.773 | 47.962 | 50.892 |

Appendix 3D

Table 1

Confidence Limits for the Expectation of a Poisson Variable

| 1-2α | 0.998 | | 0.99 | | 0.98 | | 0.95 | | 0.90 | | 1-2α |
|---|---|---|---|---|---|---|---|---|---|---|---|
| α | 0.001 | | 0.005 | | 0.01 | | 0.025 | | 0.05 | | α |
| c | Lower | Upper | Lower | Upper | Lower | Upper | Lower | Upper | Lower | Upper | c |
| 0 | 0.00000 | 6.91 | 0.00000 | 5.30 | 0.0000 | 4.61 | 0.0000 | 3.69 | 0.0000 | 3.00 | 0 |
| 1 | .00100 | 9.23 | .00501 | 7.43 | .0101 | 6.64 | 0.253 | 5.57 | .0513 | 4.74 | 1 |
| 2 | .0454 | 11.23 | .103 | 9.27 | .149 | 8.41 | .242 | 7.22 | .355 | 6.30 | 2 |
| 3 | .191 | 13.06 | .338 | 10.98 | .436 | 10.05 | .619 | 8.77 | .818 | 7.75 | 3 |
| 4 | .429 | 14.79 | .672 | 12.59 | .823 | 11.60 | 1.09 | 10.24 | 1.37 | 9.15 | 4 |
| 5 | 0.739 | 16.45 | 1.08 | 14.15 | 1.28 | 13.11 | 1.62 | 11.67 | 1.97 | 10.51 | 5 |
| 6 | 1.11 | 18.06 | 1.54 | 15.66 | 1.79 | 14.57 | 2.20 | 13.06 | 2.61 | 11.84 | 6 |
| 7 | 1.52 | 19.63 | 2.04 | 17.13 | 2.33 | 16.00 | 2.81 | 14.42 | 3.29 | 13.15 | 7 |
| 8 | 1.97 | 21.16 | 2.57 | 18.58 | 2.91 | 17.40 | 3.45 | 15.76 | 3.98 | 14.43 | 8 |
| 9 | 2.45 | 22.66 | 3.13 | 20.00 | 3.51 | 18.78 | 4.12 | 17.08 | 4.70 | 15.71 | 9 |
| 10 | 2.96 | 24.13 | 3.72 | 21.40 | 4.13 | 20.14 | 4.80 | 18.39 | 5.43 | 16.96 | 10 |
| 11 | 3.49 | 25.59 | 4.32 | 22.78 | 4.77 | 21.49 | 5.49 | 19.68 | 6.17 | 18.21 | 11 |
| 12 | 4.04 | 27.03 | 4.94 | 24.14 | 5.43 | 22.82 | 6.20 | 20.96 | 6.92 | 19.44 | 12 |
| 13 | 4.61 | 28.45 | 5.58 | 25.50 | 6.10 | 24.14 | 6.92 | 22.23 | 7.69 | 20.67 | 13 |
| 14 | 5.20 | 29.85 | 6.23 | 26.84 | 6.78 | 25.45 | 7.65 | 23.49 | 8.46 | 21.89 | 14 |
| 15 | 5.79 | 31.24 | 6.89 | 28.16 | 7.48 | 26.74 | 8.40 | 24.74 | 9.25 | 23.10 | 15 |
| 16 | 5.41 | 32.62 | 7.57 | 29.48 | 8.18 | 28.03 | 9.15 | 25.98 | 10.04 | 24.30 | 16 |
| 17 | 7.03 | 33.99 | 8.25 | 30.79 | 8.89 | 29.31 | 9.90 | 27.22 | 10.83 | 25.50 | 17 |
| 18 | 7.66 | 35.35 | 8.94 | 32.09 | 9.62 | 30.58 | 10.67 | 28.45 | 11.63 | 26.69 | 18 |
| 19 | 8.31 | 36.70 | 9.64 | 33.38 | 10.35 | 31.85 | 11.44 | 29.67 | 12.44 | 27.88 | 19 |
| 20 | 8.96 | 38.04 | 10.35 | 34.67 | 11.08 | 33.10 | 12.22 | 30.89 | 13.25 | 29.06 | 20 |
| 21 | 9.62 | 39.38 | 11.07 | 35.95 | 11.82 | 34.36 | 13.00 | 32.10 | 14.07 | 30.24 | 21 |
| 22 | 10.29 | 40.70 | 11.79 | 37.22 | 12.57 | 35.60 | 13.79 | 33.31 | 14.89 | 31.42 | 22 |
| 23 | 10.96 | 42.02 | 12.52 | 38.48 | 13.33 | 36.84 | 14.58 | 34.51 | 15.72 | 32.59 | 23 |
| 24 | 11.65 | 43.33 | 13.25 | 39.74 | 14.09 | 38.08 | 15.38 | 35.71 | 16.55 | 33.75 | 24 |
| 25 | 12.34 | 44.64 | 14.00 | 41.00 | 14.85 | 39.31 | 16.18 | 36.90 | 17.38 | 34.92 | 25 |
| 26 | 13.03 | 45.94 | 14.74 | 42.25 | 15.62 | 40.53 | 16.98 | 38.10 | 18.22 | 36.08 | 26 |
| 27 | 13.73 | 47.23 | 15.49 | 43.50 | 16.40 | 41.76 | 17.79 | 39.28 | 19.06 | 37.23 | 27 |
| 28 | 14.44 | 48.52 | 16.24 | 44.74 | 17.17 | 42.98 | 18.61 | 40.47 | 19.90 | 38.39 | 28 |
| 29 | 15.15 | 49.80 | 17.00 | 45.98 | 17.96 | 44.19 | 19.42 | 41.65 | 20.75 | 39.54 | 29 |
| 30 | 15.87 | 51.08 | 17.77 | 47.21 | 18.74 | 45.40 | 20.24 | 42.83 | 21.59 | 40.69 | 30 |
| 35 | 19.52 | 57.42 | 21.64 | 53.32 | 22.72 | 51.41 | 24.38 | 48.68 | 25.37 | 46.40 | 35 |
| 40 | 23.26 | 63.66 | 25.59 | 59.36 | 26.77 | 57.35 | 28.58 | 54.47 | 30.20 | 52.07 | 40 |
| 45 | 27.08 | 69.83 | 29.60 | 65.34 | 30.88 | 63.23 | 32.82 | 60.21 | 34.56 | 57.69 | 45 |
| 50 | 30.96 | 75.94 | 33.66 | 71.27 | 35.03 | 69.07 | 37.11 | 65.92 | 38.96 | 63.29 | 50 |

If c is the observed frequency or count and $m_A$, $m_B$ are the lower and upper confidence limits for its expectation, m, then

$$Pr(m_A \leq m \leq m_B) \leq 1-2\alpha$$

Appendix 3E

Table 1A

F Distribution: Upper 10 Per Cent Points

| $v_2$ \ $v_1$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 39.864 | 49.500 | 53.593 | 55.833 | 57.241 | 58.204 | 58.906 | 59.439 | 59.858 |
| 2 | 8.5263 | 9.0000 | 9.1618 | 9.2434 | 9.2926 | 9.3255 | 9.3491 | 9.3668 | 9.3805 |
| 3 | 5.5383 | 5.4624 | 5.3908 | 5.3427 | 5.3092 | 5.2847 | 5.2662 | 5.2517 | 5.2400 |
| 4 | 4.5448 | 4.3246 | 4.1908 | 4.1073 | 4.0506 | 4.0098 | 3.9790 | 3.9549 | 3.9357 |
| 5 | 4.0604 | 3.7797 | 3.6195 | 3.5202 | 3.4530 | 3.4045 | 3.3679 | 3.3393 | 3.3163 |
| 6 | 3.7760 | 3.4633 | 3.2888 | 3.1808 | 3.1075 | 3.0546 | 3.0145 | 2.9830 | 2.9577 |
| 7 | 3.5894 | 3.2574 | 3.0741 | 2.9605 | 2.8833 | 2.8274 | 2.7849 | 2.7516 | 2.7247 |
| 8 | 3.4579 | 3.1131 | 2.9238 | 2.8064 | 2.7265 | 2.6683 | 2.6241 | 2.5893 | 2.5612 |
| 9 | 3.3603 | 3.0065 | 2.8129 | 2.6927 | 2.6106 | 2.5509 | 2.5053 | 2.4694 | 2.4403 |
| 10 | 3.2850 | 2.9245 | 2.7277 | 2.6053 | 2.5216 | 2.4606 | 2.4140 | 2.3772 | 2.3473 |
| 11 | 3.2252 | 2.8595 | 2.6602 | 2.5362 | 2.4512 | 2.3891 | 2.3416 | 2.3040 | 2.2735 |
| 12 | 3.1765 | 2.8068 | 2.6055 | 2.4801 | 2.3940 | 2.3310 | 2.2828 | 2.2446 | 2.2135 |
| 13 | 3.1362 | 2.7632 | 2.5603 | 2.4337 | 2.3467 | 2.2830 | 2.2341 | 2.1953 | 2.1638 |
| 14 | 3.1022 | 2.7265 | 2.5222 | 2.3947 | 2.3069 | 2.2426 | 2.1931 | 2.1539 | 2.1220 |
| 15 | 3.0732 | 2.6952 | 2.4898 | 2.3614 | 2.2730 | 2.2081 | 2.1582 | 2.1185 | 2.0862 |
| 16 | 3.0481 | 2.6682 | 2.4618 | 2.3327 | 2.2438 | 2.1783 | 2.1280 | 2.0880 | 2.0553 |
| 17 | 3.0262 | 2.6446 | 2.4374 | 2.3077 | 2.2183 | 2.1524 | 2.1017 | 2.0613 | 2.0284 |
| 18 | 3.0070 | 2.6239 | 2.4160 | 2.2858 | 2.1958 | 2.1296 | 2.0785 | 2.0379 | 2.0047 |
| 19 | 2.9899 | 2.6056 | 2.3970 | 2.2663 | 2.1760 | 2.1094 | 2.0580 | 2.0171 | 1.9836 |
| 20 | 2.9747 | 2.5893 | 2.3801 | 2.2489 | 2.1582 | 2.0913 | 2.0397 | 1.9985 | 1.9649 |
| 21 | 2.9609 | 2.5746 | 2.3649 | 2.2333 | 2.1423 | 2.0751 | 2.0232 | 1.9819 | 1.9480 |
| 22 | 2.9486 | 2.5613 | 2.3512 | 2.2193 | 2.1279 | 2.0605 | 2.0084 | 1.9668 | 1.9327 |
| 23 | 2.9374 | 2.5493 | 2.3387 | 2.2065 | 2.1149 | 2.0472 | 1.9949 | 1.9531 | 1.9189 |
| 24 | 2.9271 | 2.5383 | 2.3274 | 2.1949 | 2.1030 | 2.0351 | 1.9826 | 1.9407 | 1.9063 |
| 25 | 2.9177 | 2.5283 | 2.3170 | 2.1843 | 2.0922 | 2.0241 | 1.9714 | 1.9292 | 1.8947 |
| 26 | 2.9091 | 2.5191 | 2.3075 | 2.1745 | 2.0822 | 2.0139 | 1.9610 | 1.9188 | 1.8841 |
| 27 | 2.9012 | 2.5106 | 2.2987 | 2.1655 | 2.0730 | 2.0045 | 1.9515 | 1.9091 | 1.8743 |
| 28 | 2.8939 | 2.5028 | 2.2906 | 2.1571 | 2.0645 | 1.9959 | 1.9427 | 1.9001 | 1.8652 |
| 29 | 2.8871 | 2.4955 | 2.2831 | 2.1494 | 2.0566 | 1.9878 | 1.9345 | 1.8918 | 1.8568 |
| 30 | 2.8807 | 2.4887 | 2.2761 | 2.1422 | 2.0492 | 1.9803 | 1.9269 | 1.8841 | 1.8490 |
| 40 | 2.8354 | 2 [illegible]04 | 2.2261 | 2.0909 | 1.9968 | 1.9269 | 1.8725 | 1.8289 | 1.7929 |
| 60 | 2.7914 | [illegible]932 | 2.1774 | 2.0410 | 1.9457 | 1.8747 | 1.8194 | 1.7748 | 1.7380 |
| 120 | 2.7478 | 2.3473 | 2.1300 | 1.9923 | 1.8959 | 1.8238 | 1.7675 | 1.7220 | 1.6843 |
| $\infty$ | 2.7055 | 2.3026 | 2.0838 | 1.9449 | 1.8473 | 1.7741 | 1.7167 | 1.6702 | 1.6315 |

This table gives the values of F for which $I_F(v_1, v_2) = 0.10$

One-sided 90 percent test.

Two-sided 80 percent test.

Appendix 3E

Table 1B

F Distribution: Upper 10 Percent Points

| $v_2$ \ $v_1$ | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 | $\infty$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 60.195 | 60.705 | 61.220 | 61.740 | 62.002 | 62.265 | 62.529 | 62.794 | 63.061 | 63.328 |
| 2 | 9.3916 | 9.4081 | 9.4247 | 9.4413 | 9.4496 | 9.4579 | 9.4663 | 9.4746 | 9.4829 | 9.4913 |
| 3 | 5.2304 | 5.2156 | 5.2003 | 5.1845 | 5.1764 | 5.1681 | 5.1597 | 5.1512 | 5.1425 | 5.1337 |
| 4 | 3.9199 | 3.8955 | 3.8689 | 3.8443 | 3.8310 | 3.8174 | 3.8036 | 3.7896 | 3.7753 | 3.7607 |
| 5 | 3.2974 | 3.2682 | 3.2380 | 3.2067 | 3.1905 | 3.1741 | 3.1573 | 3.1402 | 3.1228 | 3.1050 |
| 6 | 2.9369 | 2.9047 | 2.8712 | 2.8363 | 2.8183 | 2.8000 | 2.7812 | 2.7620 | 2.7423 | 2.7222 |
| 7 | 2.7025 | 2.6681 | 2.6322 | 2.5947 | 2.5753 | 2.5555 | 2.5351 | 2.5142 | 2.4928 | 2.4708 |
| 8 | 2.5380 | 2.5020 | 2.4642 | 2.4246 | 2.4041 | 2.3830 | 2.3614 | 2.3391 | 2.3162 | 2.2926 |
| 9 | 2.4163 | 2.3789 | 2.3396 | 2.2983 | 2.2768 | 2.2547 | 2.2320 | 2.2085 | 2.1843 | 2.1592 |
| 10 | 2.3226 | 2.2841 | 2.2435 | 2.2007 | 2.1784 | 2.1554 | 2.1317 | 2.1072 | 2.0818 | 2.0554 |
| 11 | 2.2482 | 2.2087 | 2.1671 | 2.1230 | 2.1000 | 2.0762 | 2.0516 | 2.0261 | 1.9997 | 1.9721 |
| 12 | 2.1878 | 2.1474 | 2.1049 | 2.0597 | 2.0360 | 2.0115 | 1.9861 | 1.9597 | 1.9323 | 1.9036 |
| 13 | 2.1376 | 2.0966 | 2.0532 | 2.0070 | 1.9827 | 1.9576 | 1.9315 | 1.9043 | 1.8759 | 1.8462 |
| 14 | 2.0954 | 2.0537 | 2.0095 | 1.9625 | 1.9377 | 1.9119 | 1.8852 | 1.8572 | 1.8280 | 1.7973 |
| 15 | 2.0593 | 2.0171 | 1.9722 | 1.9243 | 1.8990 | 1.8728 | 1.8454 | 1.8168 | 1.7867 | 1.7551 |
| 16 | 2.0281 | 1.9854 | 1.9399 | 1.8913 | 1.8656 | 1.8388 | 1.8108 | 1.7816 | 1.7507 | 1.7182 |
| 17 | 2.0009 | 1.9577 | 1.9117 | 1.8624 | 1.8362 | 1.8090 | 1.7805 | 1.7506 | 1.7191 | 1.6856 |
| 18 | 1.9770 | 1.9333 | 1.8868 | 1.8368 | 1.8103 | 1.7827 | 1.7537 | 1.7232 | 1.6910 | 1.6567 |
| 19 | 1.9557 | 1.9117 | 1.8647 | 1.8142 | 1.7873 | 1.7592 | 1.7298 | 1.6988 | 1.6659 | 1.6308 |
| 20 | 1.9367 | 1.8924 | 1.8449 | 1.7938 | 1.7667 | 1.7382 | 1.7083 | 1.6768 | 1.6433 | 1.6074 |
| 21 | 1.9197 | 1.8750 | 1.8272 | 1.7756 | 1.7481 | 1.7193 | 1.6890 | 1.6569 | 1.6228 | 1.5862 |
| 22 | 1.9043 | 1.8593 | 1.8111 | 1.7590 | 1.7312 | 1.7021 | 1.6714 | 1.6389 | 1.6042 | 1.5668 |
| 23 | 1.8903 | 1.8450 | 1.7964 | 1.7439 | 1.7159 | 1.6864 | 1.6554 | 1.6224 | 1.5871 | 1.5490 |
| 24 | 1.8775 | 1.8319 | 1.7831 | 1.7302 | 1.7019 | 1.6721 | 1.6407 | 1.6073 | 1.5715 | 1.5327 |
| 25 | 1.8658 | 1.8200 | 1.7708 | 1.7175 | 1.6890 | 1.6589 | 1.6272 | 1.5934 | 1.5570 | 1.5176 |
| 26 | 1.8550 | 1.8090 | 1.7596 | 1.7059 | 1.6771 | 1.6468 | 1.6147 | 1.5805 | 1.5437 | 1.5036 |
| 27 | 1.8451 | 1.7989 | 1.7492 | 1.6951 | 1.6662 | 1.6356 | 1.6032 | 1.5686 | 1.5313 | 1.4906 |
| 28 | 1.8359 | 1.7895 | 1.7395 | 1.6852 | 1.6560 | 1.6252 | 1.5925 | 1.5575 | 1.5198 | 1.4784 |
| 29 | 1.8274 | 1.7808 | 1.7306 | 1.6759 | 1.6465 | 1.6155 | 1.5825 | 1.5472 | 1.5090 | 1.4670 |
| 30 | 1.8195 | 1.7727 | 1.7223 | 1.6673 | 1.6377 | 1.6065 | 1.5732 | 1.5376 | 1.4989 | 1.4564 |
| 40 | 1.7627 | 1.7146 | 1.6624 | 1.6052 | 1.5741 | 1.5411 | 1.5056 | 1.4672 | 1.4248 | 1.3769 |
| 60 | 1.7070 | 1.6574 | 1.6034 | 1.5435 | 1.5107 | 1.4755 | 1.4373 | 1.3952 | 1.3476 | 1.2915 |
| 120 | 1.6524 | 1.6012 | 1.5450 | 1.4821 | 1.4472 | 1.4094 | 1.3676 | 1.3203 | 1.2646 | 1.1926 |
| $\infty$ | 1.5987 | 1.5458 | 1.4871 | 1.4206 | 1.3832 | 1.3419 | 1.2951 | 1.2400 | 1.1686 | 1.0000 |

$$F = \frac{s_1^2}{s_2^2} = \frac{v_2 S_1}{v_1 S_2}$$

**One-sided 90 percent test.**

**Two-sided 80 percent test.**

Appendix 3E

Table 2A

F Distribution: Upper 5 Per Cent Points

| $V_2$ \ $V_1$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 161.45 | 199.50 | 215.71 | 224.58 | 230.16 | 233.99 | 236.77 | 238.88 | 240.54 |
| 2 | 18.513 | 19.000 | 19.164 | 19.247 | 19.296 | 19.330 | 19.353 | 19.371 | 19.385 |
| 3 | 10.128 | 9.5521 | 9.2766 | 9.1172 | 9.0135 | 8.9406 | 8.8868 | 8.8452 | 8.8123 |
| 4 | 7.7086 | 6.9443 | 6.5914 | 6.3883 | 6.2560 | 6.1631 | 6.0942 | 6.0410 | 5.9988 |
| 5 | 6.6079 | 5.7861 | 5.4095 | 5.1922 | 5.0503 | 4.9503 | 4.8759 | 4.8183 | 4.7725 |
| 6 | 5.9874 | 5.1433 | 4.7571 | 4.5337 | 4.3874 | 4.2839 | 4.2066 | 4.1468 | 4.0990 |
| 7 | 5.5914 | 4.7374 | 4.3468 | 4.1203 | 3.9715 | 3.8660 | 3.7870 | 3.7257 | 3.6767 |
| 8 | 5.3177 | 4.4590 | 4.0662 | 3.8378 | 3.6875 | 3.5806 | 3.5005 | 3.4381 | 3.3881 |
| 9 | 5.1174 | 4.2565 | 3.8626 | 3.6331 | 3.4817 | 3.3738 | 3.2927 | 3.2296 | 3.1789 |
| 10 | 4.9646 | 4.1028 | 3.7083 | 3.4780 | 3.3258 | 3.2172 | 3.1355 | 3.0717 | 3.0204 |
| 11 | 4.8443 | 3.9823 | 3.5874 | 3.3567 | 3.2039 | 3.0946 | 3.0123 | 2.9480 | 2.8962 |
| 12 | 4.7472 | 3.8853 | 3.4903 | 3.2592 | 3.1059 | 2.9961 | 2.9134 | 2.8486 | 2.7964 |
| 13 | 4.6672 | 3.8056 | 3.4105 | 3.1791 | 3.0254 | 2.9153 | 2.8321 | 2.7669 | 2.7144 |
| 14 | 4.6001 | 3.7389 | 3.3439 | 3.1122 | 2.9582 | 2.8477 | 2.7642 | 2.6987 | 2.6458 |
| 15 | 4.5431 | 3.6823 | 3.2874 | 3.0556 | 2.9013 | 2.7905 | 2.7066 | 2.6408 | 2.5876 |
| 16 | 4.4940 | 3.6337 | 3.2389 | 3.0069 | 2.8524 | 2.7413 | 2.6572 | 2.5911 | 2.5377 |
| 17 | 4.4513 | 3.5915 | 3.1968 | 2.9647 | 2.8100 | 2.6987 | 2.6143 | 2.5480 | 2.4943 |
| 18 | 4.4139 | 3.5546 | 3.1599 | 2.9277 | 2.7729 | 2.6613 | 2.5767 | 2.5102 | 2.4563 |
| 19 | 4.3803 | 3.5219 | 3.1274 | 2.8951 | 2.7401 | 2.6283 | 2.5435 | 2.4768 | 2.4227 |
| 20 | 4.3513 | 3.4928 | 3.0984 | 2.8661 | 2.7109 | 2.5990 | 2.5140 | 2.4471 | 2.3928 |
| 21 | 4.3248 | 3.4668 | 3.0725 | 2.8401 | 2.6848 | 2.5727 | 2.4876 | 2.4205 | 2.3661 |
| 22 | 4.3009 | 3.4434 | 3.0491 | 2.8167 | 2.6613 | 2.5491 | 2.4638 | 2.3965 | 2.3419 |
| 23 | 4.2793 | 3.4221 | 3.0280 | 2.7955 | 2.6400 | 2.5277 | 2.4422 | 2.3748 | 2.3201 |
| 24 | 4.2597 | 3.4028 | 3.0088 | 2.7763 | 2.6207 | 2.5082 | 2.4226 | 2.3551 | 2.3002 |
| 25 | 4.2417 | 3.3852 | 2.9912 | 2.7587 | 2.6030 | 2.4904 | 2.4047 | 2.3371 | 2.2821 |
| 26 | 4.2252 | 3.3690 | 2.9751 | 2.7426 | 2.5868 | 2.4741 | 2.3883 | 2.3205 | 2.2655 |
| 27 | 4.2100 | 3.3541 | 2.9604 | 2.7278 | 2.5719 | 2.4591 | 2.3732 | 2.3053 | 2.2501 |
| 28 | 4.1960 | 3.3404 | 2.9467 | 2.7141 | 2.5581 | 2.4453 | 2.3593 | 2.2913 | 2.2360 |
| 29 | 4.1830 | 3.3277 | 2.9340 | 2.7014 | 2.5454 | 2.4324 | 2.3463 | 2.2782 | 2.2229 |
| 30 | 4.1709 | 3.3158 | 2.9223 | 2.6896 | 2.5336 | 2.4205 | 2.3343 | 2.2662 | 2.2107 |
| 40 | 4.0848 | 3.2317 | 2.8387 | 2.6060 | 2.4495 | 2.3359 | 2.2490 | 2.1802 | 2.1240 |
| 60 | 4.0012 | 3.1504 | 2.7581 | 2.5252 | 2.3683 | 2.2540 | 2.1665 | 2.0970 | 2.0401 |
| 120 | 3.9201 | 3.0718 | 2.6802 | 2.4472 | 2.2900 | 2.1750 | 2.0867 | 2.0164 | 1.9588 |
| $\infty$ | 3.8415 | 2.9957 | 2.6049 | 2.3719 | 2.2141 | 2.0986 | 2.0096 | 1.9384 | 1.8799 |

This table gives the values of F for which $I_F(V_1, V_2) = 0.05$.

One-sided 95 percent test.

Two-sided 90 percent test.

Appendix 3E

Table 2B

F Distribution: Upper 5 Per Cent Points

| $v_2$ \ $v_1$ | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 | ∞ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 241.88 | 243.91 | 245.95 | 248.01 | 249.05 | 250.09 | 251.14 | 252.20 | 253.25 | 254.32 |
| 2 | 19.396 | 19.413 | 19.429 | 19.446 | 19.454 | 19.462 | 19.471 | 19.479 | 19.487 | 19.496 |
| 3 | 8.7855 | 8.7446 | 8.7029 | 8.6602 | 8.6385 | 8.6166 | 8.5944 | 8.5720 | 8.5494 | 8.5265 |
| 4 | 5.9644 | 5.9117 | 5.8578 | 5.8025 | 5.7744 | 5.7459 | 5.7170 | 5.6878 | 5.6581 | 5.6281 |
| 5 | 4.7351 | 4.6777 | 4.6188 | 4.5581 | 4.5272 | 4.4957 | 4.4638 | 4.4314 | 4.3984 | 4.3650 |
| 6 | 4.0600 | 3.9999 | 3.9381 | 3.8742 | 3.8415 | 3.8082 | 3.7743 | 3.7398 | 3.7047 | 3.6688 |
| 7 | 3.6365 | 3.5747 | 3.5108 | 3.4445 | 3.4105 | 3.3758 | 3.3404 | 3.3043 | 3.2674 | 3.2298 |
| 8 | 3.3472 | 3.2840 | 3.2184 | 3.1503 | 3.1152 | 3.0794 | 3.0428 | 3.0053 | 2.9669 | 2.9276 |
| 9 | 3.1373 | 3.0729 | 3.0061 | 2.9365 | 2.9005 | 2.8637 | 2.8259 | 2.7872 | 2.7473 | 2.7067 |
| 10 | 2.9782 | 2.9130 | 2.8450 | 2.7740 | 2.7372 | 2.6996 | 2.6609 | 2.6211 | 2.5801 | 2.5379 |
| 11 | 2.8536 | 2.7876 | 2.7186 | 2.6464 | 2.6090 | 2.5705 | 2.5309 | 2.4901 | 2.4480 | 2.4045 |
| 12 | 2.7534 | 2.6866 | 2.6169 | 2.5436 | 2.5055 | 2.4663 | 2.4259 | 2.3842 | 2.3410 | 2.2962 |
| 13 | 2.6710 | 2.6037 | 2.5331 | 2.4589 | 2.4202 | 2.3803 | 2.3392 | 2.2966 | 2.2524 | 2.2064 |
| 14 | 2.6021 | 2.5342 | 2.4630 | 2.3879 | 2.3487 | 2.3082 | 2.2664 | 2.2230 | 2.1778 | 2.1307 |
| 15 | 2.5437 | 2.4753 | 2.4035 | 2.3275 | 2.2878 | 2.2468 | 2.2043 | 2.1601 | 2.1141 | 2.0658 |
| 16 | 2.4935 | 2.4247 | 2.3522 | 2.2756 | 2.2354 | 2.1938 | 2.1507 | 2.1058 | 2.0589 | 2.0096 |
| 17 | 2.4499 | 2.3807 | 2.3077 | 2.2304 | 2.1898 | 2.1477 | 2.1040 | 2.0584 | 2.0107 | 1.9604 |
| 18 | 2.4117 | 2.3421 | 2.2686 | 2.1906 | 2.1497 | 2.1071 | 2.0629 | 2.0166 | 1.9681 | 1.9168 |
| 19 | 2.3779 | 2.3080 | 2.2341 | 2.1555 | 2.1141 | 2.0712 | 2.0264 | 1.9796 | 1.9302 | 1.8780 |
| 20 | 2.3479 | 2.2776 | 2.2033 | 2.1242 | 2.0825 | 2.0391 | 1.9938 | 1.9464 | 1.8963 | 1.8432 |
| 21 | 2.3210 | 2.2504 | 2.1757 | 2.0960 | 2.0540 | 2.0102 | 1.9645 | 1.9165 | 1.8657 | 1.8117 |
| 22 | 2.2967 | 2.2258 | 2.1508 | 2.0707 | 2.0283 | 1.9842 | 1.9380 | 1.8895 | 1.8380 | 1.7831 |
| 23 | 2.2747 | 2.2036 | 2.1282 | 2.0476 | 2.0050 | 1.9605 | 1.9139 | 1.8649 | 1.8128 | 1.7570 |
| 24 | 2.2547 | 2.1834 | 2.1077 | 2.0267 | 1.9838 | 1.9390 | 1.8920 | 1.8424 | 1.7897 | 1.7331 |
| 25 | 2.2365 | 2.1649 | 2.0889 | 2.0075 | 1.9643 | 1.9192 | 1.8718 | 1.8217 | 1.7684 | 1.7110 |
| 26 | 2.2197 | 2.1479 | 2.0716 | 1.9898 | 1.9464 | 1.9010 | 1.8533 | 1.8027 | 1.7488 | 1.6906 |
| 27 | 2.2043 | 2.1323 | 2.0558 | 1.9736 | 1.9299 | 1.8842 | 1.8361 | 1.7851 | 1.7307 | 1.6717 |
| 28 | 2.1900 | 2.1179 | 2.0411 | 1.9586 | 1.9147 | 1.8687 | 1.8203 | 1.7689 | 1.7138 | 1.6541 |
| 29 | 2.1768 | 2.1045 | 2.0275 | 1.9446 | 1.9005 | 1.8543 | 1.8055 | 1.7537 | 1.6981 | 1.6377 |
| 30 | 2.1646 | 2.0921 | 2.0148 | 1.9317 | 1.8874 | 1.8409 | 1.7918 | 1.7396 | 1.6835 | 1.6223 |
| 40 | 2.0772 | 2.0035 | 1.9245 | 1.8389 | 1.7929 | 1.7444 | 1.6928 | 1.6373 | 1.5766 | 1.5089 |
| 60 | 1.9926 | 1.9174 | 1.8364 | 1.7480 | 1.7001 | 1.6491 | 1.5943 | 1.5343 | 1.4673 | 1.3893 |
| 120 | 1.9105 | 1.8337 | 1.7505 | 1.6587 | 1.6084 | 1.5543 | 1.4952 | 1.4290 | 1.3519 | 1.2539 |
| ∞ | 1.8307 | 1.7522 | 1.6664 | 1.5705 | 1.5173 | 1.4591 | 1.3940 | 1.3180 | 1.2214 | 1.0000 |

$$F = \frac{s_1^2}{s_2^2} = \frac{v_2}{v_1}\frac{S_1}{S_2}$$

One-sided 95 percent test.

Two-sided 90 percent test.

## Appendix 3E

### Table 3A

**F Distribution: Upper 2.5 Per Cent Points**

| $\nu_2$ \ $\nu_1$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 647.79 | 799.50 | 864.16 | 899.58 | 921.85 | 937.11 | 948.22 | 956.66 | 963.28 |
| 2 | 38.506 | 39.000 | 39.165 | 39.248 | 39.298 | 39.331 | 39.355 | 39.373 | 39.387 |
| 3 | 17.443 | 16.044 | 15.439 | 15.101 | 14.885 | 14.735 | 14.624 | 14.540 | 14.473 |
| 4 | 12.218 | 10.649 | 9.9792 | 9.6045 | 9.3645 | 9.1973 | 9.0741 | 8.9796 | 8.9047 |
| 5 | 10.007 | 8.4336 | 7.7636 | 7.3879 | 7.1464 | 6.9777 | 6.8531 | 6.7572 | 6.6810 |
| 6 | 8.8131 | 7.2598 | 6.5988 | 6.2272 | 5.9876 | 5.8197 | 5.6955 | 5.5996 | 5.5234 |
| 7 | 8.0727 | 6.5415 | 5.8898 | 5.5226 | 5.2852 | 5.1186 | 4.9949 | 4.8994 | 4.8232 |
| 8 | 7.5709 | 6.0595 | 5.4160 | 5.0526 | 4.8173 | 4.6517 | 4.5286 | 4.4332 | 4.3572 |
| 9 | 7.2093 | 5.7147 | 5.0781 | 4.7181 | 4.4844 | 4.3197 | 4.1971 | 4.1020 | 4.0260 |
| 10 | 6.9367 | 5.4564 | 4.8256 | 4.4683 | 4.2361 | 4.0721 | 3.9498 | 3.8549 | 3.7790 |
| 11 | 6.7241 | 5.2559 | 4.6300 | 4.2751 | 4.0440 | 3.8807 | 3.7586 | 3.6638 | 3.5879 |
| 12 | 6.5538 | 5.0959 | 4.4742 | 4.1212 | 3.8911 | 3.7283 | 3.6065 | 3.5118 | 3.4358 |
| 13 | 6.4143 | 4.9653 | 4.3472 | 3.9959 | 3.7667 | 3.6043 | 3.4827 | 3.3880 | 3.3120 |
| 14 | 6.2979 | 4.8567 | 4.2417 | 3.8919 | 3.6634 | 3.5014 | 3.3799 | 3.2853 | 3.2093 |
| 15 | 6.1995 | 4.7650 | 4.1528 | 3.8043 | 3.5764 | 3.4147 | 3.2934 | 3.1987 | 3.1227 |
| 16 | 6.1151 | 4.6867 | 4.0768 | 3.7294 | 3.5021 | 3.3406 | 3.2194 | 3.1248 | 3.0488 |
| 17 | 6.0420 | 4.6189 | 4.0112 | 3.6648 | 3.4379 | 3.2767 | 3.1556 | 3.0610 | 2.9849 |
| 18 | 5.9781 | 4.5597 | 3.9539 | 3.6083 | 3.3820 | 3.2209 | 3.0999 | 3.0053 | 2.9291 |
| 19 | 5.9216 | 4.5075 | 3.9034 | 3.5587 | 3.3327 | 3.1718 | 3.0509 | 2.9563 | 2.8800 |
| 20 | 5.8715 | 4.4613 | 3.8587 | 3.5147 | 3.2891 | 3.1283 | 3.0074 | 2.9128 | 2.8365 |
| 21 | 5.8266 | 4.4199 | 3.8188 | 3.4754 | 3.2501 | 3.0895 | 2.9686 | 2.8740 | 2.7977 |
| 22 | 5.7863 | 4.3828 | 3.7829 | 3.4401 | 3.2151 | 3.0546 | 2.9338 | 2.8392 | 2.7628 |
| 23 | 5.7498 | 4.3492 | 3.7505 | 3.4083 | 3.1835 | 3.0232 | 2.9024 | 2.8077 | 2.7313 |
| 24 | 5.7167 | 4.3187 | 3.7211 | 3.3794 | 3.1548 | 2.9946 | 2.8738 | 2.7791 | 2.7027 |
| 25 | 5.6864 | 4.2909 | 3.6943 | 3.3530 | 3.1287 | 2.9685 | 2.8478 | 2.7531 | 2.6766 |
| 26 | 5.6586 | 4.2655 | 3.6697 | 3.3289 | 3.1048 | 2.9447 | 2.8240 | 2.7293 | 2.6528 |
| 27 | 5.6331 | 4.2421 | 3.6472 | 3.3067 | 3.0828 | 2.9228 | 2.8021 | 2.7074 | 2.6309 |
| 28 | 5.6096 | 4.2205 | 3.6264 | 3.2863 | 3.0625 | 2.9027 | 2.7820 | 2.6872 | 2.6106 |
| 29 | 5.5878 | 4.2006 | 3.6072 | 3.2674 | 3.0438 | 2.8840 | 2.7633 | 2.6686 | 2.5919 |
| 30 | 5.5675 | 4.1821 | 3.5894 | 3.2499 | 3.0265 | 2.8667 | 2.7460 | 2.6513 | 2.5746 |
| 40 | 5.4239 | 4.0510 | 3.4633 | 3.1261 | 2.9037 | 2.7444 | 2.6238 | 2.5289 | 2.4519 |
| 60 | 5.2857 | 3.9253 | 3.3425 | 3.0077 | 2.7863 | 2.6274 | 2.5068 | 2.4117 | 2.3344 |
| 120 | 5.1524 | 3.8046 | 3.2270 | 2.8943 | 2.6740 | 2.5154 | 2.3948 | 2.2994 | 2.2217 |
| $\infty$ | 5.0239 | 3.6889 | 3.1161 | 2.7858 | 2.5665 | 2.4082 | 2.2875 | 2.1918 | 2.1136 |

This table gives the values of F for which $I_F(\nu_1, \nu_2) = 0.025$.

One-sided 97.5 percent test.
Two-sided 95.0 percent test.

Appendix 3E

Table 3B

F Distribution: Upper 2.5 Per Cent Points

| $V_2$ \ $V_1$ | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 | $\infty$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 968.63 | 976.71 | 984.87 | 993.10 | 997.25 | 1001.4 | 1005.6 | 1009.8 | 1014.0 | 1018.3 |
| 2 | 39.398 | 39.415 | 39.431 | 39.448 | 39.456 | 39.465 | 39.473 | 39.481 | 39.490 | 39.498 |
| 3 | 14.419 | 14.337 | 14.253 | 14.167 | 14.124 | 14.081 | 14.037 | 13.992 | 13.947 | 13.902 |
| 4 | 8.8439 | 8.7512 | 8.6565 | 8.5599 | 8.5109 | 8.4613 | 8.4111 | 8.3604 | 8.3092 | 8.2573 |
| 5 | 6.6192 | 6.5246 | 6.4277 | 6.3285 | 6.2780 | 6.2269 | 6.1751 | 6.1225 | 6.0693 | 6.0153 |
| 6 | 5.4613 | 5.3662 | 5.2687 | 5.1684 | 5.1172 | 5.0652 | 5.0125 | 4.9589 | 4.9045 | 4.8491 |
| 7 | 4.7611 | 4.6658 | 4.5678 | 4.4667 | 4.4150 | 4.3624 | 4.3089 | 4.2544 | 4.1989 | 4.1423 |
| 8 | 4.2951 | 4.1997 | 4.1012 | 3.9995 | 3.9472 | 3.8940 | 3.8398 | 3.7844 | 3.7279 | 3.6702 |
| 9 | 3.9639 | 3.8682 | 3.7694 | 3.6669 | 3.6142 | 3.5604 | 3.5055 | 3.4493 | 3.3918 | 3.3329 |
| 10 | 3.7168 | 3.6209 | 3.5217 | 3.4186 | 3.3654 | 3.3110 | 3.2554 | 3.1984 | 3.1399 | 3.0798 |
| 11 | 3.5257 | 3.4296 | 3.3299 | 3.2261 | 3.1725 | 3.1176 | 3.0613 | 3.0035 | 2.9441 | 2.8828 |
| 12 | 3.3736 | 3.2773 | 3.1772 | 3.0728 | 3.0187 | 2.9633 | 2.9063 | 2.8478 | 2.7874 | 2.7249 |
| 13 | 3.2497 | 3.1532 | 3.0527 | 2.9477 | 2.8932 | 2.8373 | 2.7797 | 2.7204 | 2.6590 | 2.5955 |
| 14 | 3.1469 | 3.0501 | 2.9493 | 2.8437 | 2.7888 | 2.7324 | 2.6742 | 2.6142 | 2.5519 | 2.4872 |
| 15 | 3.0602 | 2.9633 | 2.8621 | 2.7559 | 2.7006 | 2.6437 | 2.5850 | 2.5242 | 2.4611 | 2.3953 |
| 16 | 2.9862 | 2.8890 | 2.7875 | 2.6808 | 2.6252 | 2.5678 | 2.5085 | 2.4471 | 2.3831 | 2.3163 |
| 17 | 2.9222 | 2.8249 | 2.7230 | 2.6158 | 2.5598 | 2.5021 | 2.4422 | 2.3801 | 2.3153 | 2.2474 |
| 18 | 2.8664 | 2.7689 | 2.6667 | 2.5590 | 2.5027 | 2.4445 | 2.3842 | 2.3214 | 2.2558 | 2.1869 |
| 19 | 2.8173 | 2.7196 | 2.6171 | 2.5089 | 2.4523 | 2.3937 | 2.3329 | 2.2695 | 2.2032 | 2.1333 |
| 20 | 2.7737 | 2.6758 | 2.5731 | 2.4645 | 2.4076 | 2.3486 | 2.2873 | 2.2234 | 2.1562 | 2.0853 |
| 21 | 2.7348 | 2.6368 | 2.5338 | 2.4247 | 2.3675 | 2.3082 | 2.2465 | 2.1819 | 2.1141 | 2.0422 |
| 22 | 2.6998 | 2.6017 | 2.4984 | 2.3890 | 2.3315 | 2.2718 | 2.2097 | 2.1446 | 2.0760 | 2.0032 |
| 23 | 2.6682 | 2.5699 | 2.4665 | 2.3567 | 2.2989 | 2.2389 | 2.1763 | 2.1107 | 2.0415 | 1.9677 |
| 24 | 2.6396 | 2.5412 | 2.4374 | 2.3273 | 2.2693 | 2.2090 | 2.1460 | 2.0799 | 2.0099 | 1.9353 |
| 25 | 2.6135 | 2.5149 | 2.4110 | 2.3005 | 2.2422 | 2.1816 | 2.1183 | 2.0517 | 1.9811 | 1.9055 |
| 26 | 2.5895 | 2.4909 | 2.3867 | 2.2759 | 2.2174 | 2.1565 | 2.0928 | 2.0257 | 1.9545 | 1.8781 |
| 27 | 2.5676 | 2.4688 | 2.3644 | 2.2533 | 2.1946 | 2.1334 | 2.0693 | 2.0018 | 1.9299 | 1.8527 |
| 28 | 2.5473 | 2.4484 | 2.3438 | 2.2324 | 2.1735 | 2.1121 | 2.0477 | 1.9796 | 1.9072 | 1.8291 |
| 29 | 2.5286 | 2.4295 | 2.3248 | 2.2131 | 2.1540 | 2.0923 | 2.0276 | 1.9591 | 1.8861 | 1.8072 |
| 30 | 2.5112 | 2.4120 | 2.3072 | 2.1952 | 2.1359 | 2.0739 | 2.0089 | 1.9400 | 1.8664 | 1.7867 |
| 40 | 2.3882 | 2.2882 | 2.1819 | 2.0677 | 2.0069 | 1.9429 | 1.8752 | 1.8028 | 1.7242 | 1.6371 |
| 60 | 2.2702 | 2.1692 | 2.0613 | 1.9445 | 1.8817 | 1.8152 | 1.7440 | 1.6668 | 1.5810 | 1.4822 |
| 120 | 2.1570 | 2.0548 | 1.9450 | 1.8249 | 1.7597 | 1.6899 | 1.6141 | 1.5299 | 1.4327 | 1.3104 |
| $\infty$ | 2.0483 | 1.9447 | 1.8326 | 1.7085 | 1.6402 | 1.5660 | 1.4835 | 1.3883 | 1.2684 | 1.0000 |

$$F = \frac{s_1^2}{s_2^2} = \frac{v_2 S_1}{v_1 S_2}$$

One-sided 97.5 percent test.
Two-sided 95.0 percent test.

Appendix 3E

Table 4A

F Distribution: Upper 1 Per Cent Points

| $V_2$ \ $V_1$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4052.2 | 4999.5 | 5403.3 | 5624.6 | 5763.7 | 5859.0 | 5928.3 | 5981.6 | 6022.5 |
| 2 | 98.503 | 99.000 | 99.166 | 99.249 | 99.299 | 99.332 | 99.356 | 99.374 | 99.388 |
| 3 | 34.116 | 30.817 | 29.457 | 28.710 | 28.237 | 27.911 | 27.672 | 27.489 | 27.345 |
| 4 | 21.198 | 18.000 | 16.694 | 15.977 | 15.522 | 15.207 | 14.976 | 14.799 | 14.659 |
| 5 | 16.258 | 13.274 | 12.060 | 11.392 | 10.967 | 10.672 | 10.456 | 10.289 | 10.158 |
| 6 | 13.745 | 10.925 | 9.7795 | 9.1483 | 8.7459 | 8.4661 | 8.2600 | 8.1016 | 7.9761 |
| 7 | 12.246 | 9.5466 | 8.4513 | 7.8467 | 7.4604 | 7.1914 | 6.9928 | 6.8401 | 6.7188 |
| 8 | 11.259 | 8.6491 | 7.5910 | 7.0060 | 6.6318 | 6.3707 | 6.1776 | 6.0289 | 5.9106 |
| 9 | 10.561 | 8.0215 | 6.9919 | 6.4221 | 6.0569 | 5.8018 | 5.6129 | 5.4671 | 5.3511 |
| 10 | 10.044 | 7.5594 | 6.5523 | 5.9943 | 5.6363 | 5.3858 | 5.2001 | 5.0567 | 4.9424 |
| 11 | 9.6460 | 7.2057 | 6.2167 | 5.6683 | 5.3160 | 5.0692 | 4.8861 | 4.7445 | 4.6315 |
| 12 | 9.3302 | 6.9266 | 5.9526 | 5.4119 | 5.0643 | 4.8206 | 4.6395 | 4.4994 | 4.3875 |
| 13 | 9.0738 | 6.7010 | 5.7394 | 5.2053 | 4.8616 | 4.6204 | 4.4410 | 4.3021 | 4.1911 |
| 14 | 8.8616 | 6.5149 | 5.5639 | 5.0354 | 4.6950 | 4.4558 | 4.2779 | 4.1399 | 4.0297 |
| 15 | 8.6831 | 6.3589 | 5.4170 | 4.8932 | 4.5556 | 4.3183 | 4.1415 | 4.0045 | 3.8948 |
| 16 | 8.5310 | 6.2262 | 5.2922 | 4.7726 | 4.4374 | 4.2016 | 4.0259 | 3.8896 | 3.7804 |
| 17 | 8.3997 | 6.1121 | 5.1850 | 4.6690 | 4.3359 | 4.1015 | 3.9267 | 3.7910 | 3.6822 |
| 18 | 8.2854 | 6.0129 | 5.0919 | 4.5790 | 4.2479 | 4.0146 | 3.8406 | 3.7054 | 3.5971 |
| 19 | 8.1850 | 5.9259 | 5.0103 | 4.5003 | 4.1708 | 3.9386 | 3.7653 | 3.6305 | 3.5225 |
| 20 | 8.0960 | 5.8489 | 4.9382 | 4.4307 | 4.1027 | 3.8714 | 3.6987 | 3.5644 | 3.4567 |
| 21 | 8.0166 | 5.7804 | 4.8740 | 4.3688 | 4.0421 | 3.8117 | 3.6396 | 3.5056 | 3.3961 |
| 22 | 7.9454 | 5.7190 | 4.8166 | 4.3134 | 3.9880 | 3.7583 | 3.5867 | 3.4530 | 3.3458 |
| 23 | 7.8811 | 5.6637 | 4.7649 | 4.2635 | 3.9392 | 3.7102 | 3.5290 | 3.4057 | 3.2986 |
| 24 | 7.8229 | 5.6136 | 4.7181 | 4.2184 | 3.8951 | 3.6667 | 3.4959 | 3.3629 | 3.2560 |
| 25 | 7.7698 | 5.5680 | 4.6755 | 4.1774 | 3.8550 | 3.6272 | 3.4568 | 3.3239 | 3.2172 |
| 26 | 7.7213 | 5.5263 | 4.6366 | 4.1400 | 3.8183 | 3.5911 | 3.4210 | 3.2884 | 3.1818 |
| 27 | 7.6767 | 5.4881 | 4.0009 | 4.1056 | 3.7848 | 3.5580 | 3.3882 | 3.2558 | 3.1494 |
| 28 | 7.6356 | 5.4529 | 4.5681 | 4.0740 | 3.7539 | 3.5276 | 3.3581 | 3.2259 | 3.1195 |
| 29 | 7.5976 | 5.4205 | 4.5378 | 4.0449 | 3.7254 | 3.4995 | 3.3302 | 3.1982 | 3.0920 |
| 30 | 7.5625 | 5.3904 | 4.5097 | 4.0179 | 3.6990 | 3.4735 | 3.3045 | 3.1726 | 3.0665 |
| 40 | 7.3141 | 5.1785 | 4.3126 | 3.8283 | 3.5138 | 3.2910 | 3.1238 | 2.9930 | 2.8876 |
| 60 | 7.0771 | 4.9774 | 4.1259 | 3.6491 | 3.3389 | 3.1187 | 2.9530 | 2.8233 | 2.7185 |
| 120 | 6.8510 | 4.7865 | 3.9493 | 3.4796 | 3.1735 | 2.9559 | 2.7918 | 2.6629 | 2.5586 |
| $\infty$ | 6.6349 | 4.6052 | 3.7816 | 3.3192 | 3.0173 | 2.8020 | 2.6393 | 2.5113 | 2.4073 |

This table gives the values of F for which $I_F(v_1, v_2) = 0.01$.

One-sided 99 percent test.

Two-sided 98 percent test.

Appendix 3E

Table 4B

F Distribution: Upper 1 Per Cent Points

| $V_2 \backslash V_1$ | 10 | 12 | 15 | 20 | 24 | 30 | 40 | 60 | 120 | ∞ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6055.8 | 6106.3 | 6157.3 | 6208.7 | 6234.6 | 6260.7 | 6286.8 | 6313.0 | 6339.4 | 6366.0 |
| 2 | 99.399 | 99.416 | 99.432 | 99.449 | 99.458 | 99.466 | 99.474 | 99.483 | 99.491 | 99.501 |
| 3 | 27.229 | 27.052 | 26.872 | 26.690 | 26.598 | 26.505 | 26.411 | 26.316 | 26.221 | 26.125 |
| 4 | 14.546 | 14.374 | 14.198 | 14.020 | 13.929 | 13.838 | 13.745 | 13.652 | 13.558 | 13.463 |
| 5 | 10.051 | 9.8883 | 9.7222 | 9.5527 | 9.4665 | 9.3793 | 9.2912 | 9.2020 | 9.1118 | 9.0204 |
| 6 | 7.8741 | 7.7183 | 7.5590 | 7.3958 | 7.3127 | 7.2285 | 7.1432 | 7.0568 | 6.9690 | 6.8801 |
| 7 | 6.6201 | 6.4691 | 6.3143 | 6.1554 | 6.0743 | 5.9921 | 5.9084 | 5.8326 | 5.7572 | 5.6495 |
| 8 | 5.8143 | 5.6668 | 5.5151 | 5.3591 | 5.2793 | 5.1981 | 5.1156 | 5.0316 | 4.9460 | 4.8588 |
| 9 | 5.2565 | 5.1114 | 4.9621 | 4.8080 | 4.7290 | 4.6486 | 4.5667 | 4.4831 | 4.3978 | 4.3105 |
| 10 | 4.8492 | 4.7059 | 4.5582 | 4.4054 | 4.3269 | 4.2469 | 4.1653 | 4.0819 | 3.9965 | 3.9090 |
| 11 | 4.5393 | 4.3974 | 4.2509 | 4.0990 | 4.0209 | 3.9411 | 3.8596 | 3.7761 | 3.6904 | 3.6025 |
| 12 | 4.2961 | 4.1553 | 4.0096 | 3.8584 | 3.7805 | 3.7008 | 3.6192 | 3.5355 | 3.4494 | 3.3608 |
| 13 | 4.1003 | 3.9603 | 3.8154 | 3.6646 | 3.5868 | 3.5070 | 3.4253 | 3.3413 | 3.2548 | 3.1654 |
| 14 | 3.9394 | 3.8001 | 3.6557 | 3.5052 | 3.4274 | 3.3476 | 3.2656 | 3.1813 | 3.0942 | 3.0040 |
| 15 | 3.8049 | 3.6662 | 3.5222 | 3.3719 | 3.2940 | 3.2141 | 3.1319 | 3.0471 | 2.9595 | 2.8684 |
| 16 | 3.6909 | 3.5527 | 3.4089 | 3.2588 | 3.1808 | 3.1007 | 3.0182 | 2.9330 | 2.8447 | 2.7528 |
| 17 | 3.5931 | 3.4552 | 3.3117 | 3.1615 | 3.0835 | 3.0032 | 2.9205 | 2.8348 | 2.7459 | 2.6530 |
| 18 | 3.5082 | 3.3706 | 3.2273 | 3.0771 | 2.9990 | 2.9185 | 2.8354 | 2.7493 | 2.6597 | 2.5660 |
| 19 | 3.4338 | 3.2965 | 3.1533 | 3.0031 | 2.9249 | 2.8442 | 2.7608 | 2.6742 | 2.5839 | 2.4893 |
| 20 | 3.3682 | 3.2311 | 3.0880 | 2.9377 | 2.8594 | 2.7785 | 2.6947 | 2.6077 | 2.5168 | 2.4212 |
| 21 | 3.3098 | 3.1729 | 3.0299 | 2.8796 | 2.8011 | 2.7200 | 2.6359 | 2.5484 | 2.4568 | 2.3603 |
| 22 | 3.2576 | 3.1209 | 2.9780 | 2.8274 | 2.7488 | 2.6675 | 2.5831 | 2.4951 | 2.4029 | 2.3055 |
| 23 | 3.2106 | 3.0740 | 2.9311 | 2.7805 | 2.7017 | 2.6202 | 2.5355 | 2.4471 | 2.3542 | 2.2559 |
| 24 | 3.1681 | 3.0316 | 2.8887 | 2.7380 | 2.6591 | 2.5773 | 2.4923 | 2.4035 | 2.3099 | 2.2107 |
| 25 | 3.1294 | 2.9931 | 2.8502 | 2.6993 | 2.6203 | 2.5383 | 2.4530 | 2.3637 | 2.2695 | 2.1694 |
| 26 | 3.0941 | 2.9579 | 2.8150 | 2.6640 | 2.5848 | 2.5026 | 2.4170 | 2.3273 | 2.2325 | 2.1315 |
| 27 | 3.0618 | 2.9256 | 2.7827 | 2.6316 | 2.5522 | 2.4699 | 2.3840 | 2.2938 | 2.1984 | 2.0965 |
| 28 | 3.0320 | 2.8959 | 2.7530 | 2.6017 | 2.5223 | 2.4397 | 2.3535 | 2.2629 | 2.1670 | 2.0642 |
| 29 | 3.0045 | 2.8685 | 2.7256 | 2.5742 | 2.4946 | 2.4118 | 2.3253 | 2.2344 | 2.1378 | 2.0342 |
| 30 | 2.9791 | 2.8431 | 2.7002 | 2.5487 | 2.4689 | 2.3860 | 2.2992 | 2.2079 | 2.1107 | 2.0062 |
| 40 | 2.8005 | 2.6648 | 2.5216 | 2.3689 | 2.2880 | 2.2034 | 2.1142 | 2.0194 | 1.9172 | 1.8047 |
| 60 | 2.6318 | 2.4961 | 2.3523 | 2.1978 | 2.1154 | 2.0285 | 1.9360 | 1.8363 | 1.7263 | 1.6006 |
| 120 | 2.4721 | 2.3363 | 2.1915 | 2.0346 | 1.9500 | 1.8600 | 1.7628 | 1.6557 | 1.5330 | 1.3805 |
| ∞ | 2.3209 | 2.1848 | 2.0385 | 1.8783 | 1.7908 | 1.6964 | 1.5923 | 1.4730 | 1.3246 | 1.0000 |

$$F = \frac{s_1^2}{s_2^2} = \frac{v_2 S_1}{v_1 S_2}$$

One-sided 99 percent test.

Two-sided 98 percent test.

Appendix 3F

Student's t-Distribution

| df | .60 | .70 | .80 | .90 | .95 | .975 | .99 | .995 |
|---|---|---|---|---|---|---|---|---|
| 1 | .325 | .727 | 1.376 | 3.078 | 6.314 | 12.706 | 31.821 | 63.657 |
| 2 | .289 | .617 | 1.061 | 1.886 | 2.920 | 4.303 | 6.965 | 9.925 |
| 3 | .277 | .584 | .978 | 1.638 | 2.353 | 3.182 | 4.541 | 5.841 |
| 4 | .271 | .569 | .941 | 1.533 | 2.132 | 2.776 | 3.747 | 4.604 |
| 5 | .267 | .559 | .920 | 1.476 | 2.015 | 2.571 | 3.365 | 4.032 |
| 6 | .265 | .553 | .906 | 1.440 | 1.943 | 2.447 | 3.143 | 3.707 |
| 7 | .263 | .549 | .896 | 1.415 | 1.895 | 2.365 | 2.998 | 3.499 |
| 8 | .262 | .546 | .889 | 1.397 | 1.860 | 2.306 | 2.896 | 3.355 |
| 9 | .261 | .543 | .883 | 1.383 | 1.833 | 2.262 | 2.821 | 3.250 |
| 10 | .260 | .542 | .879 | 1.372 | 1.812 | 2.228 | 2.764 | 3.169 |
| 11 | .260 | .540 | .876 | 1.363 | 1.796 | 2.201 | 2.718 | 3.106 |
| 12 | .259 | .539 | .873 | 1.356 | 1.782 | 2.179 | 2.681 | 3.055 |
| 13 | .259 | .538 | .870 | 1.350 | 1.771 | 2.160 | 2.650 | 3.012 |
| 14 | .258 | .537 | .868 | 1.345 | 1.761 | 2.145 | 2.624 | 2.977 |
| 15 | .258 | .536 | .866 | 1.341 | 1.753 | 2.131 | 2.602 | 2.947 |
| 16 | .258 | .535 | .865 | 1.337 | 1.746 | 2.120 | 2.583 | 2.921 |
| 17 | .257 | .534 | .863 | 1.333 | 1.740 | 2.110 | 2.567 | 2.898 |
| 18 | .257 | .534 | .862 | 1.330 | 1.734 | 2.101 | 2.552 | 2.878 |
| 19 | .257 | .533 | .861 | 1.328 | 1.729 | 2.093 | 2.539 | 2.861 |
| 20 | .257 | .533 | .860 | 1.325 | 1.725 | 2.086 | 2.528 | 2.845 |
| 21 | .257 | .532 | .859 | 1.323 | 1.721 | 2.080 | 2.518 | 2.831 |
| 22 | .256 | .532 | .858 | 1.321 | 1.717 | 2.074 | 2.508 | 2.819 |
| 23 | .256 | .532 | .858 | 1.319 | 1.714 | 2.069 | 2.500 | 2.807 |
| 24 | .256 | .531 | .857 | 1.318 | 1.711 | 2.064 | 2.492 | 2.797 |
| 25 | .256 | .531 | .856 | 1.316 | 1.708 | 2.060 | 2.485 | 2.787 |
| 26 | .256 | .531 | .856 | 1.315 | 1.706 | 2.056 | 2.479 | 2.779 |
| 27 | .256 | .531 | .855 | 1.314 | 1.703 | 2.052 | 2.473 | 2.771 |
| 28 | .256 | .530 | .855 | 1.313 | 1.701 | 2.048 | 2.467 | 2.763 |
| 29 | .256 | .530 | .854 | 1.311 | 1.699 | 2.045 | 2.462 | 2.756 |
| 30 | .256 | .530 | .854 | 1.310 | 1.697 | 2.042 | 2.457 | 2.750 |
| 40 | .255 | .529 | .851 | 1.303 | 1.684 | 2.021 | 2.423 | 2.704 |
| 60 | .254 | .527 | .848 | 1.296 | 1.671 | 2.000 | 2.390 | 2.660 |
| 120 | .254 | .526 | .845 | 1.289 | 1.658 | 1.980 | 2.358 | 2.617 |
| ∞ | .253 | .524 | .842 | 1.282 | 1.645 | 1.960 | 2.326 | 2.576 |
| df | | | | | | | | |

## APPENDIX 3G

### Areas Under the Standard Normal Curve to the Right of the Ordinate

| T | A | T | A | T | A | T | A |
|---|---|---|---|---|---|---|---|
| .00 | .5000000 | .22 | .4129356 | .44 | .3299686 | .66 | .2546269 |
| .01 | .4960106 | .23 | .4090459 | .45 | .3263552 | .67 | .2514289 |
| .02 | .4920217 | .24 | .4051651 | .46 | .3227581 | .68 | .2482522 |
| .03 | .4880335 | .25 | .4012937 | .47 | .3191775 | .69 | .2450971 |
| .04 | .4840466 | .26 | .3974319 | .48 | .3156137 | .70 | .2419637 |
| .05 | .4800612 | .27 | .3935801 | .49 | .3120669 | .71 | .2388521 |
| .06 | .4760778 | .28 | .3897388 | .50 | .3085375 | .72 | .2357625 |
| .07 | .4720968 | .29 | .3859081 | .51 | .3050257 | .73 | .2326951 |
| .08 | .4681186 | .30 | .3820886 | .52 | .3015318 | .74 | .2296500 |
| .09 | .4641436 | .31 | .3782805 | .53 | .2980560 | .75 | .2266274 |
| .10 | .4601722 | .32 | .3744842 | .54 | .2945985 | .76 | .2236273 |
| .11 | .4562047 | .33 | .3707000 | .55 | .2911597 | .77 | .2206499 |
| .12 | .4522416 | .34 | .3669283 | .56 | .2877397 | .78 | .2176954 |
| .13 | .4482832 | .35 | .3631693 | .57 | .2843388 | .79 | .2147639 |
| .14 | .4443300 | .36 | .3594236 | .58 | .2809573 | .80 | .2118554 |
| .15 | .4403823 | .37 | .3556912 | .59 | .2775953 | .81 | .2089701 |
| .16 | .4364405 | .38 | .3519727 | .60 | .2742531 | .82 | .2061081 |
| .17 | .4325051 | .39 | .3482683 | .61 | .2709309 | .83 | .2032694 |
| .18 | .4285763 | .40 | .3445783 | .62 | .2676289 | .84 | .2004542 |
| .19 | .4246546 | .41 | .3409030 | .63 | .2643473 | .85 | .1976625 |
| .20 | .4207403 | .42 | .3372427 | .64 | .2610863 | .86 | .1948945 |
| .21 | .4168338 | .43 | .3335978 | .65 | .2578461 | .87 | .1921502 |

APPENDIX 3G (continued)

| T | A | T | A | T | A | T | A |
|---|---|---|---|---|---|---|---|
| .88 | .1894297 | 1.16 | .1230244 | 1.44 | .0749337 | 1.72 | .0427162 |
| .89 | .1867329 | 1.17 | .1210005 | 1.45 | .0735293 | 1.73 | .0418[illegible]51 |
| .90 | .1840601 | 1.18 | .1190001 | 1.46 | .0721450 | 1.74 | .0409295 |
| .91 | .1814113 | 1.19 | .1170232 | 1.47 | .0707809 | 1.75 | .0400592 |
| .92 | .1787864 | 1.20 | .1150697 | 1.48 | .0694366 | 1.76 | .0392039 |
| .93 | .1761855 | 1.21 | .1131394 | 1.49 | .0681121 | 1.77 | .0383636 |
| .94 | .1736088 | 1.22 | .1112324 | 1.50 | .0668072 | 1.78 | .0375380 |
| .95 | .1710561 | 1.23 | .1093486 | 1.51 | .0655217 | 1.79 | .0367270 |
| .96 | .1685276 | 1.24 | .1074877 | 1.52 | .0642555 | 1.80 | .0359303 |
| .97 | .1660203 | 1.25 | .1056498 | 1.53 | .0630084 | 1.81 | .0351479 |
| .98 | .1635431 | 1.26 | .1038347 | 1.54 | .0617802 | 1.82 | .0343795 |
| .99 | .1610871 | 1.27 | .1020423 | 1.55 | .0605708 | 1.83 | .0336250 |
| 1.00 | .1586553 | 1.28 | .1002726 | 1.56 | .0593799 | 1.84 | .0328841 |
| 1.01 | .1562476 | 1.29 | .0985253 | 1.57 | .0582076 | 1.85 | .0321568 |
| 1.02 | .1538642 | 1.30 | .0968005 | 1.58 | .0570534 | 1.86 | .0314428 |
| 1.03 | .1515050 | 1.31 | .0950979 | 1.59 | .0559174 | 1.87 | .0307419 |
| 1.04 | .1491700 | 1.32 | .0934175 | 1.60 | .0547993 | 1.88 | .0300540 |
| 1.05 | .1468591 | 1.33 | .0917591 | 1.61 | .0536989 | 1.89 | .0293790 |
| 1.06 | .1445723 | 1.34 | .0901227 | 1.62 | .0526161 | 1.90 | .0287166 |
| 1.07 | .1423097 | 1.35 | .0885080 | 1.63 | .0515507 | 1.91 | .0280666 |
| 1.08 | .1400711 | 1.36 | .0869150 | 1.64 | .0505026 | 1.92 | .0274289 |
| 1.09 | .1378566 | 1.37 | .0853435 | 1.65 | .0494715 | 1.93 | .0268034 |
| 1.10 | .1356661 | 1.38 | .0837933 | 1.66 | .0484572 | 1.94 | .0261898 |
| 1.11 | .1334995 | 1.39 | .0822644 | 1.67 | .0474597 | 1.95 | .0255881 |
| 1.12 | .1313569 | 1.40 | .0807567 | 1.68 | .0464787 | 1.96 | .0249979 |
| 1.13 | .1292381 | 1.41 | .0792698 | 1.69 | .0455140 | 1.97 | .0244192 |
| 1.14 | .1271432 | 1.42 | .0778038 | 1.70 | .0445655 | 1.98 | .0238518 |
| 1.15 | .1250719 | 1.43 | .0763585 | 1.71 | .0436329 | 1.99 | .0232955 |

APPENDIX 3G (continued)

| T | A | T | A | T | A | T | A |
|---|---|---|---|---|---|---|---|
| 2.00 | .0227501 | 2.26 | .0119106 | 2.52 | .0058677 | 2.78 | .0027179 |
| 2.01 | .0222156 | 2.27 | .0116038 | 2.53 | .0057031 | 2.79 | .0026354 |
| 2.02 | .0216917 | 2.28 | .0113038 | 2.54 | .0055426 | 2.80 | .0025551 |
| 2.03 | .0211783 | 2.29 | .0110107 | 2.55 | .0053861 | 2.81 | .0024771 |
| 2.04 | .0206752 | 2.30 | .0107241 | 2.56 | .0052336 | 2.82 | .0024012 |
| 2.05 | .0201822 | 2.31 | .0104441 | 2.57 | .0050849 | 2.83 | .0023274 |
| 2.06 | .0196993 | 2.32 | .0101704 | 2.58 | .0049400 | 2.84 | .0022557 |
| 2.07 | .0192262 | 2.33 | .0099031 | 2.59 | .0047988 | 2.85 | .0021860 |
| 2.08 | .0187628 | 2.34 | .0096419 | 2.60 | .0046612 | 2.86 | .0021182 |
| 2.09 | .0183089 | 2.35 | .0093867 | 2.61 | .0045271 | 2.87 | .0020524 |
| 2.10 | .0178644 | 2.36 | .0091375 | 2.62 | .0043965 | 2.88 | .0019884 |
| 2.11 | .0174292 | 2.37 | .0088940 | 2.63 | .0042692 | 2.89 | .0019262 |
| 2.12 | .0170030 | 2.38 | .0086563 | 2.64 | .0041453 | 2.90 | .0018658 |
| 2.13 | .0165858 | 2.39 | .0084242 | 2.65 | .0040246 | 2.91 | .0018071 |
| 2.14 | .0161774 | 2.40 | .0081975 | 2.66 | .0039070 | 2.92 | .0017502 |
| 2.15 | .0157776 | 2.41 | .0079763 | 2.67 | .0037926 | 2.93 | .0016948 |
| 2.16 | .0153863 | 2.42 | .0077603 | 2.68 | .0036811 | 2.94 | .0016411 |
| 2.17 | .0150034 | 2.43 | .0075494 | 2.69 | .0035726 | 2.95 | .0015889 |
| 2.18 | .0146287 | 2.44 | .0073436 | 2.70 | .0034670 | 2.96 | .0015382 |
| 2.19 | .0142621 | 2.45 | .0071428 | 2.71 | .0033642 | 2.97 | .0014890 |
| 2.20 | .0139034 | 2.46 | .0069469 | 2.72 | .0032641 | 2.98 | .0014412 |
| 2.21 | .0135526 | 2.47 | .0067557 | 2.73 | .0031667 | 2.99 | .0013949 |
| 2.22 | .0132094 | 2.48 | .0065691 | 2.74 | .0030720 | 3.00 | .0013449 |
| 2.23 | .0128737 | 2.49 | .0063872 | 2.75 | .0029708 | 3.01 | .0013062 |
| 2.24 | .0125455 | 2.50 | .0062097 | 2.76 | .0028901 | 3.02 | .0012639 |
| 2.25 | .0122245 | 2.51 | .0060366 | 2.77 | .0028028 | 3.03 | .0012228 |

APPENDIX 3G (continued)

| T | A | T | A | T | A | T | A |
|---|---|---|---|---|---|---|---|
| 3.04 | .0011829 | 3.28 | .0005190 | 3.52 | .0002158 | 3.76 | .0000850 |
| 3.05 | .0011442 | 3.29 | .0005009 | 3.53 | .0002078 | 3.77 | .0000816 |
| 3.06 | .0011067 | 3.30 | .0004834 | 3.54 | .0002001 | 3.78 | .0000784 |
| 3.07 | .0010703 | 3.31 | .0004665 | 3.55 | .0001926 | 3.79 | .0000753 |
| 3.08 | .0010350 | 3.32 | .0004501 | 3.56 | .0001854 | 3.80 | .0000723 |
| 3.09 | .0010008 | 3.33 | .0004342 | 3.57 | .0001785 | 3.81 | .0000695 |
| 3.10 | .0009676 | 3.34 | .0004189 | 3.58 | .0001718 | 3.82 | .0000667 |
| 3.11 | .0009354 | 3.35 | .0004041 | 3.59 | .0001653 | 3.83 | .0000641 |
| 3.12 | .0009043 | 3.36 | .0003897 | 3.60 | .0001591 | 3.84 | .0000615 |
| 3.13 | .0008740 | 3.37 | .0003758 | 3.61 | .0001531 | 3.85 | .0000591 |
| 3.14 | .0008447 | 3.38 | .0003624 | 3.62 | .0001473 | 3.86 | .0000567 |
| 3.15 | .0008164 | 3.39 | .0003495 | 3.63 | .0001417 | 3.87 | .0000544 |
| 3.16 | .0007888 | 3.40 | .0003369 | 3.64 | .0001363 | 3.88 | .0000522 |
| 3.17 | .0007622 | 3.41 | .0003248 | 3.65 | .0001311 | 3.89 | .0000501 |
| 3.18 | .0007364 | 3.42 | .0003131 | 3.66 | .0001261 | 3.90 | .0000481 |
| 3.19 | .0007114 | 3.43 | .0003018 | 3.67 | .0001213 | 3.91 | .0000461 |
| 3.20 | .0006871 | 3.44 | .0002909 | 3.68 | .0001166 | 3.92 | .0000443 |
| 3.21 | .0006637 | 3.45 | .0002803 | 3.69 | .0001121 | 3.93 | .0000425 |
| 3.22 | .0006410 | 3.46 | .0002701 | 3.70 | .0001078 | 3.94 | .0000407 |
| 3.23 | .0006190 | 3.47 | .0002602 | 3.71 | .0001036 | 3.95 | .0000391 |
| 3.24 | .0005976 | 3.48 | .0002507 | 3.72 | .0000996 | 3.96 | .0000375 |
| 3.25 | .0005770 | 3.49 | .0002415 | 3.73 | .0000957 | 3.97 | .0000359 |
| 3.26 | .0005571 | 3.50 | .0002326 | 3.74 | .0000920 | 3.98 | .0000345 |
| 3.27 | .0005377 | 3.51 | .0002241 | 3.75 | .0000884 | 3.99 | .0000330 |

| T | A | T | A | T | A | T | A |
|---|---|---|---|---|---|---|---|
| 4.00 | .0000317 | 4.27 | .0000098 | 4.54 | .0000028 | | |
| 4.01 | .0000304 | 4.28 | .0000093 | 4.55 | .0000027 | | |
| 4.02 | .0000291 | 4.29 | .0000089 | 4.56 | .0000026 | | |
| 4.03 | .0000279 | 4.30 | .0000085 | 4.57 | .0000024 | | |
| 4.04 | .0000267 | 4.31 | .0000082 | 4.58 | .0000023 | | |
| 4.05 | .0000256 | 4.32 | .0000078 | 4.59 | .0000022 | | |
| 4.06 | .0000245 | 4.33 | .0000075 | 4.60 | .0000021 | | |
| 4.07 | .0000235 | 4.34 | .0000071 | 4.61 | .0000020 | | |
| 4.08 | .0000225 | 4.35 | .0000068 | 4.63 | .0000019 | | |
| 4.09 | .0000216 | 4.36 | .0000065 | 4.63 | .0000018 | | |
| 4.10 | .0000207 | 4.37 | .0000062 | 4.64 | .0000017 | | |
| 4.11 | .0000198 | 4.38 | .0000059 | 4.65 | .0000017 | | |
| 4.12 | .0000189 | 4.39 | .0000057 | 4.66 | .0000016 | | |
| 4.13 | .0000181 | 4.40 | .0000054 | 4.67 | .0000015 | | |
| 4.14 | .0000174 | 4.41 | .0000052 | | | | |
| 4.15 | .0000166 | 4.42 | .0000049 | | | | |
| 4.16 | .0000159 | 4.43 | .0000047 | | | | |
| 4.17 | .0000152 | 4.44 | .0000045 | | | | |
| 4.18 | .0000146 | 4.45 | .0000043 | | | | |
| 4.19 | .0000139 | 4.46 | .0000041 | | | | |
| 4.20 | .0000133 | 4.47 | .0000039 | | | | |
| 4.21 | .0000128 | 4.48 | .0000037 | | | | |
| 4.22 | .0000122 | 4.49 | .0000036 | | | | |
| 4.23 | .0000117 | 4.50 | .0000034 | | | | |
| 4.24 | .0000112 | 4.51 | .0000032 | | | | |
| 4.25 | .0000107 | 4.52 | .0000031 | | | | |
| 4.26 | .0000102 | 4.53 | .0000030 | | | | |

Appendix 3H

Table I

Upper 90- and 95-Percent Confidence Bounds for the Number of Defectives in a Finite Population of 40 Members.

| Number of Observed Defectives | Sample Size 2: 90 | 2: 95 | 4: 90 | 4: 95 | 8: 90 | 8: 95 | 16: 90 | 16: 95 | 32: 90 | 32: 95 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 26 | 30 | 16 | 20 | 9 | 11 | 4 | 5 | 1 | 1 |
| 1 | 37 | 38 | 26 | 29 | 15 | 17 | 7 | 8 | 2 | 3 |
| 2 | 40 | 40 | 33 | 35 | 20 | 22 | 10 | 11 | 4 | 4 |
| 3 | | | 38 | 39 | 25 | 27 | 13 | 14 | 5 | 6 |
| 4 | | | 40 | 40 | 29 | 31 | 16 | 17 | 7 | 7 |
| 5 | | | | | 33 | 34 | 18 | 20 | 8 | 9 |
| 6 | | | | | 36 | 37 | 21 | 22 | 9 | 10 |
| 7 | | | | | 39 | 39 | 23 | 24 | 11 | 11 |
| 8 | | | | | 40 | 40 | 25 | 27 | 12 | 13 |
| 9 | | | | | | | 28 | 29 | 13 | 14 |
| 10 | | | | | | | 30 | 31 | 15 | 15 |
| 11 | | | | | | | 32 | 33 | 16 | 16 |
| 12 | | | | | | | 34 | 35 | 17 | 18 |
| 13 | | | | | | | 36 | 37 | 18 | 19 |
| 14 | | | | | | | 38 | 38 | 20 | 20 |
| 15 | | | | | | | 39 | 39 | 21 | 21 |
| 16 | | | | | | | 40 | 40 | 22 | 23 |
| 17 | | | | | | | | | 23 | 24 |
| 18 | | | | | | | | | 25 | 25 |
| 19 | | | | | | | | | 26 | 26 |
| 20 | | | | | | | | | 27 | 27 |
| 21 | | | | | | | | | 28 | 29 |
| 22 | | | | | | | | | 29 | 30 |
| 23 | | | | | | | | | 31 | 31 |
| 24 | | | | | | | | | 32 | 32 |
| 25 | | | | | | | | | 33 | 33 |
| 26 | | | | | | | | | 34 | 34 |
| 27 | | | | | | | | | 35 | 35 |
| 28 | | | | | | | | | 36 | 36 |
| 29 | | | | | | | | | 37 | 37 |
| 30 | | | | | | | | | 38 | 38 |
| 31 | | | | | | | | | 39 | 39 |
| 32 | | | | | | | | | 40 | 40 |

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Table 2

Upper 90- and 95-Percent Confidence Bounds for the Number of Defectives in a Finite Population of 60 Members.

| Number of Observed Defectives | Sample Size 3 | | 6 | | 12 | | 24 | | 48 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 0 | 31 | 37 | 18 | 22 | 9 | 11 | 4 | 5 | 1 | 1 |
| 1 | 47 | 51 | 29 | 33 | 16 | 18 | 7 | 9 | 2 | 3 |
| 2 | 57 | 58 | 39 | 42 | 21 | 24 | 10 | 12 | 4 | 4 |
| 3 | 60 | 60 | 47 | 50 | 27 | 30 | 13 | 15 | 5 | 6 |
| 4 | | | 54 | 55 | 32 | 35 | 16 | 18 | 7 | 7 |
| 5 | | | 58 | 59 | 37 | 39 | 19 | 21 | 8 | 9 |
| 6 | | | 60 | 60 | 41 | 44 | 22 | 23 | 10 | 10 |
| 7 | | | | | 46 | 48 | 24 | 26 | 11 | 12 |
| 8 | | | | | 50 | 51 | 27 | 29 | 12 | 13 |
| 9 | | | | | 53 | 54 | 29 | 31 | 14 | 14 |
| 10 | | | | | 56 | 57 | 32 | 33 | 15 | 16 |
| 11 | | | | | 59 | 59 | 34 | 36 | 16 | 17 |
| 12 | | | | | 60 | 60 | 37 | 38 | 17 | 18 |
| 13 | | | | | | | 39 | 41 | 19 | 19 |
| 14 | | | | | | | 41 | 43 | 20 | 21 |
| 15 | | | | | | | 44 | 45 | 21 | 22 |
| 16 | | | | | | | 46 | 47 | 23 | 23 |
| 17 | | | | | | | 48 | 49 | 24 | 25 |
| 18 | | | | | | | 50 | 51 | 25 | 26 |
| 19 | | | | | | | 52 | 53 | 26 | 27 |
| 20 | | | | | | | 54 | 55 | 28 | 28 |

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Table 2 (Continued)

Upper 90- and 95-Percent Confidence Bounds for the Number of Defectives in A Finite Population of 60 Members.

| Number of Observed Defectives | Sample Size 3 | | 6 | | 12 | | 24 | | 48 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 21 | | | | | | | 56 | 57 | 29 | 30 |
| 22 | | | | | | | 58 | 58 | 30 | 31 |
| 23 | | | | | | | 59 | 59 | 31 | 32 |
| 24 | | | | | | | 60 | 60 | 33 | 33 |
| 25 | | | | | | | | | 34 | 34 |
| 26 | | | | | | | | | 35 | 36 |
| 27 | | | | | | | | | 36 | 37 |
| 28 | | | | | | | | | 37 | 38 |
| 29 | | | | | | | | | 39 | 39 |
| 30 | | | | | | | | | 40 | 40 |
| 31 | | | | | | | | | 41 | 42 |
| 32 | | | | | | | | | 42 | 43 |
| 33 | | | | | | | | | 44 | 44 |
| 34 | | | | | | | | | 45 | 45 |
| 35 | | | | | | | | | 46 | 46 |

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Table 3

Upper 90- and 95-Percent Confidence Bounds for the Number of Defectives in a Finite Population of 100 Members.

| Number of Observed Defectives | Sample Size 5 | | 10 | | 20 | | 40 | | 80 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 0 | 36 | 44 | 19 | 24 | 9 | 12 | 4 | 5 | 1 | 1 |
| 1 | 57 | 64 | 32 | 38 | 16 | 19 | 7 | 9 | 3 | 3 |
| 2 | 74 | 80 | 43 | 49 | 23 | 26 | 11 | 12 | 4 | 5 |
| 3 | 88 | 91 | 54 | 59 | 28 | 32 | 14 | 15 | 5 | 6 |
| 4 | 97 | 98 | 63 | 68 | 34 | 38 | 17 | 19 | 7 | 7 |
| 5 | 100 | 100 | 72 | 76 | 39 | 43 | 19 | 21 | 8 | 9 |
| 6 | | | 80 | 84 | 45 | 48 | 22 | 24 | 10 | 10 |
| 7 | | | 87 | 90 | 50 | 53 | 25 | 27 | 11 | 12 |
| 8 | | | 94 | 95 | 55 | 58 | 28 | 30 | 12 | 13 |
| 9 | | | 98 | 99 | 60 | 63 | 30 | 33 | 14 | 14 |
| 10 | | | 100 | 100 | 64 | 68 | 33 | 35 | 15 | 16 |
| 11 | | | | | 69 | 72 | 36 | 38 | 16 | 17 |
| 12 | | | | | 73 | 76 | 38 | 41 | 18 | 18 |
| 13 | | | | | 78 | 80 | 41 | 43 | 19 | 20 |
| 14 | | | | | 82 | 84 | 44 | 46 | 20 | 21 |
| 15 | | | | | 86 | 88 | 46 | 48 | 22 | 22 |
| 16 | | | | | 90 | 91 | 49 | 51 | 23 | 24 |
| 17 | | | | | 93 | 95 | 51 | 53 | 24 | 25 |
| 18 | | | | | 97 | 97 | 54 | 56 | 25 | 26 |
| 19 | | | | | 99 | 99 | 56 | 58 | 27 | 28 |
| 20 | | | | | 100 | 100 | 58 | 61 | 28 | 29 |
| 21 | | | | | | | 61 | 63 | 29 | 30 |
| 22 | | | | | | | 63 | 65 | 31 | 32 |
| 23 | | | | | | | 66 | 68 | 32 | 33 |
| 24 | | | | | | | 68 | 70 | 33 | 34 |
| 25 | | | | | | | 70 | 72 | 34 | 35 |
| 26 | | | | | | | 73 | 75 | 36 | 37 |
| 27 | | | | | | | 75 | 77 | 37 | 38 |
| 28 | | | | | | | 77 | 79 | 38 | 39 |
| 29 | | | | | | | 80 | 81 | 40 | 40 |
| 30 | | | | | | | 82 | 83 | 41 | 42 |
| 31 | | | | | | | 84 | 85 | 42 | 43 |
| 32 | | | | | | | 86 | 87 | 43 | 44 |
| 33 | | | | | | | 88 | 89 | 45 | 45 |
| 34 | | | | | | | 90 | 91 | 46 | 47 |
| 35 | | | | | | | 92 | 93 | 47 | 48 |

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Table 4

Upper 90- and 95-Percent Confidence Bounds for the Number of Defectives in a Finite Population of 200 Members.

| Number of Observed Defectives | Sample Size 10: 90 | 10: 95 | 20: 90 | 20: 95 | 40: 90 | 40: 95 | 80: 90 | 80: 95 | 160: 90 | 160: 95 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 40 | 50 | 20 | 26 | 10 | 12 | 4 | 5 | 1 | 1 |
| 1 | 66 | 77 | 34 | 41 | 17 | 20 | 8 | 9 | 3 | 3 |
| 2 | 88 | 100 | 47 | 54 | 23 | 27 | 11 | 13 | 4 | 5 |
| 3 | 109 | 120 | 59 | 66 | 30 | 34 | 14 | 16 | 5 | 6 |
| 4 | 128 | 138 | 70 | 78 | 36 | 40 | 17 | 19 | 7 | 8 |
| 5 | 145 | 154 | 81 | 89 | 42 | 46 | 20 | 22 | 8 | 9 |
| 6 | 161 | 169 | 91 | 99 | 47 | 52 | 23 | 25 | 10 | 10 |
| 7 | 176 | 181 | 102 | 109 | 53 | 58 | 26 | 28 | 11 | 12 |
| 8 | 188 | 192 | 112 | 119 | 58 | 63 | 29 | 31 | 12 | 13 |
| 9 | 197 | 198 | 121 | 128 | 64 | 69 | 31 | 34 | 14 | 15 |
| 10 | 200 | 200 | 131 | 137 | 69 | 74 | 34 | 37 | 15 | 16 |
| 11 | | | 140 | 146 | 74 | 80 | 37 | 40 | 16 | 17 |
| 12 | | | 149 | 155 | 80 | 85 | 40 | 42 | 18 | 19 |
| 13 | | | 157 | 163 | 85 | 90 | 42 | 45 | 19 | 20 |
| 14 | | | 165 | 170 | 90 | 95 | 45 | 48 | 20 | 21 |
| 15 | | | 173 | 178 | 95 | 100 | 48 | 51 | 22 | 23 |
| 16 | | | 181 | 184 | 100 | 105 | 50 | 53 | 23 | 24 |
| 17 | | | 188 | 190 | 105 | 110 | 53 | 56 | 22 | 23 |
| 18 | | | 194 | 196 | 110 | 115 | 56 | 59 | 26 | 27 |
| 19 | | | 198 | 199 | 115 | 120 | 58 | 61 | 27 | 28 |
| 20 | | | 200 | 200 | 120 | 125 | 61 | 64 | 28 | 29 |
| 21 | | | | | 125 | 129 | 64 | 67 | 30 | 31 |
| 22 | | | | | 129 | 134 | 66 | 69 | 31 | 32 |
| 23 | | | | | 134 | 139 | 69 | 72 | 32 | 33 |
| 24 | | | | | 139 | 143 | 71 | 74 | 34 | 35 |
| 25 | | | | | 143 | 148 | 74 | 77 | 35 | 36 |
| 26 | | | | | 148 | 152 | 77 | 80 | 36 | 37 |
| 27 | | | | | 153 | 157 | 79 | 82 | 37 | 39 |
| 28 | | | | | 157 | 161 | 82 | 85 | 39 | 40 |
| 29 | | | | | 161 | 165 | 84 | 87 | 40 | 41 |
| 30 | | | | | 166 | 169 | 87 | 90 | 41 | 43 |
| 31 | | | | | 170 | 173 | 89 | 92 | 43 | 44 |
| 32 | | | | | 174 | 177 | 92 | 95 | 44 | 45 |
| 33 | | | | | 178 | 181 | 94 | 97 | 45 | 46 |
| 34 | | | | | 182 | 185 | 97 | 100 | 47 | 48 |
| 35 | | | | | 186 | 188 | 99 | 102 | 48 | 49 |

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Table 5

Upper 90- and 95- Percent Confidence Bounds for the Number of Defects in a Finite Population of 240 Members.

| Number of Observed Defectives | Sample Size 12 | | 24 | | 48 | | 96 | | 192 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 0 | 40 | 51 | 20 | 26 | 10 | 13 | 4 | 5 | 1 | 1 |
| 1 | 67 | 79 | 35 | 42 | 17 | 21 | 8 | 9 | 3 | 3 |
| 2 | 91 | 103 | 48 | 55 | 24 | 28 | 11 | 13 | 4 | 5 |
| 3 | 112 | 125 | 60 | 68 | 30 | 34 | 14 | 16 | 5 | 6 |
| 4 | 133 | 144 | 71 | 80 | 36 | 41 | 17 | 19 | 7 | 8 |
| 5 | 152 | 163 | 83 | 91 | 42 | 47 | 20 | 22 | 8 | 9 |
| 6 | 169 | 179 | 93 | 102 | 48 | 53 | 23 | 25 | 10 | 10 |
| 7 | 186 | 195 | 104 | 112 | 53 | 58 | 26 | 28 | 11 | 12 |
| 8 | 202 | 209 | 114 | 123 | 59 | 64 | 29 | 31 | 12 | 13 |
| 9 | 216 | 222 | 124 | 133 | 64 | 70 | 31 | 34 | 14 | 15 |
| 10 | 228 | 232 | 134 | 142 | 70 | 75 | 34 | 37 | 15 | 16 |
| 11 | 237 | 239 | 144 | 152 | 75 | 81 | 37 | 40 | 16 | 17 |
| 12 | 240 | 240 | 153 | 161 | 81 | 86 | 40 | 43 | 18 | 19 |
| 13 | | | 163 | 170 | 86 | 92 | 43 | 45 | 19 | 20 |
| 14 | | | 172 | 179 | 91 | 97 | 45 | 48 | 20 | 21 |
| 15 | | | 180 | 187 | 96 | 102 | 48 | 51 | 22 | 23 |
| 16 | | | 189 | 195 | 102 | 107 | 51 | 54 | 23 | 23 |
| 17 | | | 198 | 203 | 107 | 112 | 53 | 56 | 24 | 25 |
| 18 | | | 206 | 211 | 112 | 117 | 56 | 59 | 26 | 27 |
| 19 | | | 213 | 218 | 117 | 122 | 59 | 62 | 27 | 28 |
| 20 | | | 221 | 224 | 122 | 127 | 61 | 65 | 28 | 29 |
| 21 | | | 228 | 230 | 127 | 132 | 64 | 67 | 30 | 31 |
| 22 | | | 234 | 236 | 132 | 137 | 67 | 70 | 31 | 32 |
| 23 | | | 239 | 239 | 137 | 142 | 69 | 73 | 32 | 33 |
| 24 | | | 240 | 240 | 142 | 147 | 72 | 75 | 34 | 35 |
| 25 | | | | | 146 | 152 | 74 | 78 | 35 | 36 |
| 26 | | | | | 151 | 156 | 77 | 30 | 36 | 37 |
| 27 | | | | | 156 | 161 | 80 | 83 | 38 | 39 |
| 28 | | | | | 161 | 166 | 82 | 86 | 39 | 40 |
| 29 | | | | | 165 | 170 | 85 | 88 | 40 | 41 |
| 30 | | | | | 170 | 175 | 87 | 91 | 41 | 43 |
| 31 | | | | | 175 | 179 | 90 | 93 | 43 | 44 |
| 32 | | | | | 179 | 184 | 93 | 96 | 44 | 45 |
| 33 | | | | | 184 | 188 | 95 | 99 | 45 | 47 |
| 34 | | | | | 188 | 193 | 98 | 101 | 47 | 48 |
| 35 | | | | | 193 | 197 | 100 | 104 | 48 | 49 |

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Table 6

Upper 90- and 95- Percent Confidence Bounds for the Number of Defectives in a Finite Population of 300 Members.

| Number of Observed Defectives | Sample Size 15 | | 30 | | 60 | | 120 | | 240 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 0 | 41 | 53 | 21 | 27 | 10 | 13 | 4 | 5 | 1 | 1 |
| 1 | 69 | 82 | 35 | 42 | 17 | 21 | 8 | 9 | 3 | 3 |
| 2 | 93 | 107 | 48 | 56 | 24 | 28 | 11 | 13 | 4 | 5 |
| 3 | 116 | 130 | 61 | 69 | 30 | 34 | 14 | 16 | 5 | 6 |
| 4 | 137 | 151 | 73 | 81 | 36 | 41 | 17 | 19 | 7 | 8 |
| 5 | 158 | 171 | 84 | 93 | 42 | 47 | 20 | 22 | 8 | 9 |
| 6 | 177 | 190 | 95 | 104 | 48 | 53 | 23 | 25 | 10 | 10 |
| 7 | 196 | 208 | 106 | 115 | 54 | 59 | 26 | 28 | 11 | 12 |
| 8 | 214 | 225 | 117 | 126 | 60 | 65 | 29 | 31 | 12 | 13 |
| 9 | 231 | 241 | 127 | 137 | 65 | 71 | 32 | 34 | 14 | 15 |
| 10 | 247 | 256 | 138 | 147 | 71 | 76 | 34 | 37 | 15 | 16 |
| 11 | 262 | 270 | 148 | 157 | 76 | 82 | 37 | 40 | 16 | 17 |
| 12 | 276 | 282 | 158 | 167 | 82 | 88 | 40 | 43 | 18 | 19 |
| 13 | 288 | 292 | 168 | 177 | 87 | 93 | 43 | 46 | 19 | 20 |
| 14 | 297 | 299 | 177 | 186 | 92 | 98 | 45 | 49 | 21 | 21 |
| 15 | 300 | 300 | 187 | 196 | 98 | 104 | 48 | 51 | 22 | 23 |
| 16 | | | 196 | 205 | 103 | 109 | 51 | 54 | 23 | 24 |
| 17 | | | 206 | 214 | 108 | 114 | 54 | 57 | 24 | 26 |
| 18 | | | 215 | 223 | 113 | 120 | 56 | 60 | 26 | 27 |
| 19 | | | 224 | 231 | 119 | 125 | 59 | 62 | 27 | 28 |
| 20 | | | 233 | 240 | 124 | 130 | 62 | 65 | 28 | 30 |
| 21 | | | 241 | 248 | 129 | 135 | 64 | 68 | 30 | 31 |
| 22 | | | 250 | 256 | 134 | 140 | 67 | 70 | 31 | 32 |
| 23 | | | 285 | 264 | 139 | 145 | 70 | 73 | 32 | 34 |
| 24 | | | 266 | 271 | 144 | 150 | 72 | 76 | 34 | 35 |
| 25 | | | 274 | 278 | 149 | 155 | 75 | 79 | 35 | 36 |
| 26 | | | 281 | 285 | 154 | 160 | 78 | 81 | 36 | 37 |
| 27 | | | 288 | 291 | 159 | 165 | 80 | 84 | 38 | 39 |
| 28 | | | 294 | 296 | 164 | 170 | 83 | 87 | 39 | 40 |
| 29 | | | 298 | 299 | 169 | 175 | 86 | 89 | 40 | 41 |
| 30 | | | 300 | 300 | 174 | 180 | 88 | 92 | 42 | 43 |
| 31 | | | | | 179 | 185 | 91 | 94 | 43 | 44 |
| 32 | | | | | 184 | 190 | 93 | 97 | 44 | 45 |
| 33 | | | | | 189 | 194 | 96 | 100 | 45 | 47 |
| 34 | | | | | 193 | 199 | 99 | 102 | 47 | 48 |
| 35 | | | | | 198 | 204 | 101 | 105 | 48 | 49 |

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Table 7

Upper 90- and 95- Percent Confidence Bounds for the Number of Defectives in a Finite Population of 360 Members.

| Number of Observed Defectives | Sample Size 18 | | 36 | | 72 | | 144 | | 288 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 0 | 42 | 53 | 21 | 27 | 10 | 13 | 4 | 5 | 1 | 1 |
| 1 | 70 | 84 | 36 | 43 | 17 | 21 | 8 | 9 | 3 | 3 |
| 2 | 95 | 110 | 49 | 57 | 24 | 28 | 11 | 13 | 4 | 5 |
| 3 | 119 | 133 | 61 | 70 | 30 | 35 | 14 | 16 | 5 | 6 |
| 4 | 141 | 156 | 73 | 82 | 36 | 41 | 17 | 19 | 7 | 8 |
| 5 | 162 | 177 | 85 | 94 | 42 | 47 | 20 | 22 | 8 | 9 |
| 6 | 182 | 197 | 96 | 106 | 48 | 54 | 23 | 25 | 10 | 10 |
| 7 | 202 | 217 | 108 | 117 | 54 | 60 | 26 | 28 | 11 | 12 |
| 8 | 221 | 235 | 118 | 129 | 60 | 66 | 29 | 31 | 12 | 13 |
| 9 | 240 | 253 | 129 | 139 | 66 | 71 | 32 | 34 | 14 | 15 |
| 10 | 258 | 270 | 140 | 150 | 71 | 77 | 35 | 37 | 15 | 16 |
| 11 | 275 | 287 | 150 | 161 | 77 | 83 | 37 | 40 | 17 | 17 |
| 12 | 292 | 302 | 161 | 171 | 82 | 88 | 40 | 43 | 18 | 19 |
| 13 | 308 | 317 | 171 | 181 | 88 | 94 | 43 | 46 | 19 | 20 |
| 14 | 323 | 330 | 181 | 191 | 93 | 100 | 46 | 49 | 21 | 22 |
| 15 | 336 | 342 | 191 | 201 | 99 | 105 | 48 | 52 | 22 | 23 |
| 16 | 348 | 352 | 201 | 211 | 104 | 110 | 51 | 54 | 23 | 24 |
| 17 | 357 | 359 | 211 | 220 | 109 | 116 | 54 | 57 | 25 | 26 |
| 18 | 360 | 360 | 220 | 230 | 115 | 121 | 57 | 60 | 26 | 27 |
| 19 | | | 230 | 239 | 120 | 127 | 59 | 63 | 27 | 28 |
| 20 | | | 239 | 248 | 125 | 132 | 62 | 65 | 28 | 30 |
| 21 | | | 248 | 257 | 130 | 137 | 65 | 68 | 30 | 31 |
| 22 | | | 258 | 266 | 135 | 142 | 67 | 71 | 31 | 32 |
| 23 | | | 267 | 275 | 141 | 148 | 70 | 74 | 32 | 34 |
| 24 | | | 276 | 284 | 146 | 153 | 73 | 76 | 34 | 35 |
| 25 | | | 285 | 292 | 151 | 158 | 75 | 79 | 35 | 36 |
| 26 | | | 293 | 300 | 156 | 163 | 78 | 82 | 36 | 38 |
| 27 | | | 302 | 308 | 161 | 168 | 81 | 84 | 38 | 39 |
| 28 | | | 310 | 316 | 166 | 173 | 83 | 87 | 39 | 40 |
| 29 | | | 318 | 324 | 171 | 178 | 86 | 90 | 40 | 42 |
| 30 | | | 326 | 331 | 176 | 183 | 89 | 92 | 42 | 43 |
| 31 | | | 334 | 338 | 181 | 188 | 91 | 95 | 43 | 44 |
| 32 | | | 341 | 345 | 186 | 193 | 94 | 98 | 44 | 45 |
| 33 | | | 348 | 351 | 191 | 198 | 96 | 100 | 45 | 47 |
| 34 | | | 354 | 356 | 196 | 203 | 99 | 103 | 47 | 48 |
| 35 | | | 359 | 359 | 201 | 208 | 102 | 106 | 48 | 49 |

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Table 8

Upper 90- and 95-Percent Confidence Bounds for the Number of Defectives in a Finite Population of 400 Members.

| Number of Observed Defectives | Sample Size 20 | | 40 | | 80 | | 160 | | 320 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 0 | 42 | 54 | 21 | 27 | 10 | 13 | 4 | 5 | 1 | 1 |
| 1 | 71 | 84 | 36 | 43 | 17 | 21 | 8 | 9 | 3 | 3 |
| 2 | 96 | 111 | 49 | 57 | 24 | 28 | 11 | 13 | 4 | 5 |
| 3 | 120 | 135 | 62 | 70 | 30 | 35 | 14 | 16 | 5 | 6 |
| 4 | 142 | 158 | 74 | 83 | 37 | 41 | 17 | 19 | 7 | 8 |
| 5 | 164 | 180 | 86 | 95 | 43 | 48 | 20 | 22 | 8 | 9 |
| 6 | 185 | 201 | 97 | 107 | 49 | 54 | 23 | 26 | 10 | 10 |
| 7 | 205 | 221 | 108 | 119 | 54 | 60 | 26 | 29 | 11 | 12 |
| 8 | 225 | 240 | 119 | 130 | 60 | 66 | 29 | 32 | 12 | 13 |
| 9 | 244 | 259 | 130 | 141 | 66 | 72 | 32 | 34 | 14 | 15 |
| 10 | 263 | 277 | 141 | 152 | 71 | 77 | 35 | 37 | 15 | 16 |
| 11 | 281 | 294 | 152 | 162 | 77 | 83 | 37 | 40 | 17 | 17 |
| 12 | 299 | 311 | 162 | 173 | 83 | 89 | 40 | 43 | 18 | 19 |
| 13 | 316 | 327 | 172 | 183 | 88 | 94 | 43 | 46 | 19 | 20 |
| 14 | 332 | 342 | 183 | 194 | 94 | 100 | 46 | 49 | 21 | 22 |
| 15 | 348 | 357 | 193 | 204 | 99 | 106 | 48 | 52 | 22 | 23 |
| 16 | 363 | 370 | 203 | 214 | 104 | 111 | 51 | 54 | 23 | 24 |
| 17 | 376 | 382 | 213 | 224 | 110 | 117 | 54 | 57 | 25 | 26 |
| 18 | 388 | 392 | 223 | 233 | 115 | 122 | 57 | 60 | 26 | 27 |
| 19 | 397 | 399 | 233 | 243 | 120 | 127 | 59 | 63 | 27 | 28 |
| 20 | 400 | 400 | 242 | 253 | 126 | 133 | 62 | 66 | 29 | 30 |
| 21 | | | 252 | 262 | 131 | 138 | 65 | 68 | 30 | 31 |
| 22 | | | 261 | 271 | 136 | 143 | 68 | 71 | 31 | 32 |
| 23 | | | 271 | 280 | 141 | 149 | 70 | 74 | 32 | 34 |
| 24 | | | 280 | 289 | 147 | 154 | 73 | 77 | 34 | 35 |
| 25 | | | 289 | 298 | 152 | 159 | 76 | 79 | 35 | 36 |
| 26 | | | 298 | 307 | 157 | 164 | 78 | 82 | 36 | 38 |
| 27 | | | 307 | 316 | 162 | 169 | 81 | 85 | 38 | 39 |
| 28 | | | 316 | 324 | 167 | 174 | 84 | 87 | 39 | 40 |
| 29 | | | 325 | 333 | 172 | 180 | 86 | 90 | 40 | 42 |
| 30 | | | 333 | 341 | 177 | 185 | 89 | 93 | 42 | 43 |
| 31 | | | 342 | 349 | 183 | 190 | 91 | 95 | 43 | 44 |
| 32 | | | 350 | 357 | 188 | 195 | 94 | 98 | 44 | 46 |
| 33 | | | 358 | 364 | 193 | 200 | 97 | 101 | 46 | 47 |
| 34 | | | 366 | 371 | 198 | 205 | 99 | 103 | 47 | 48 |
| 35 | | | 374 | 378 | 203 | 210 | 102 | 106 | 48 | 49 |

Table 9

Upper 90- and 95-Percent Confidence Bounds for the Number of Defectives in a Finite Population of 500 Members.

| Number of Observed Defectives | Sample Size 25 | | 50 | | 100 | | 200 | | 400 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 | 90 | 95 |
| 0 | 42 | 55 | 21 | 27 | 10 | 13 | 4 | 5 | 1 | 1 |
| 1 | 72 | 86 | 36 | 43 | 17 | 21 | 8 | 9 | 3 | 3 |
| 2 | 98 | 113 | 49 | 58 | 24 | 28 | 11 | 13 | 4 | 5 |
| 3 | 122 | 138 | 62 | 71 | 30 | 35 | 14 | 16 | 5 | 6 |
| 4 | 145 | 162 | 74 | 84 | 37 | 42 | 17 | 19 | 7 | 8 |
| 5 | 168 | 185 | 86 | 96 | 43 | 48 | 20 | 22 | 8 | 9 |
| 6 | 190 | 207 | 98 | 109 | 49 | 54 | 23 | 26 | 10 | 10 |
| 7 | 211 | 229 | 110 | 120 | 55 | 60 | 26 | 29 | 11 | 12 |
| 8 | 232 | 249 | 121 | 132 | 60 | 66 | 29 | 32 | 12 | 13 |
| 9 | 252 | 269 | 132 | 143 | 66 | 72 | 32 | 35 | 14 | 15 |
| 10 | 272 | 289 | 143 | 155 | 72 | 78 | 35 | 38 | 15 | 16 |
| 11 | 291 | 308 | 154 | 166 | 78 | 84 | 37 | 40 | 17 | 17 |
| 12 | 310 | 327 | 165 | 176 | 83 | 90 | 40 | 43 | 18 | 19 |
| 13 | 329 | 345 | 175 | 187 | 89 | 95 | 43 | 46 | 19 | 20 |
| 14 | 348 | 363 | 186 | 198 | 94 | 101 | 46 | 49 | 21 | 22 |
| 15 | 366 | 380 | 196 | 208 | 100 | 107 | 49 | 52 | 22 | 23 |
| 16 | 383 | 397 | 207 | 219 | 105 | 112 | 51 | 55 | 23 | 24 |
| 17 | 400 | 413 | 217 | 229 | 111 | 118 | 54 | 58 | 25 | 26 |
| 18 | 417 | 428 | 227 | 239 | 116 | 123 | 57 | 60 | 26 | 27 |
| 19 | 433 | 443 | 237 | 250 | 121 | 129 | 60 | 63 | 27 | 28 |
| 20 | 448 | 457 | 247 | 260 | 127 | 134 | 62 | 66 | 29 | 30 |
| 21 | 463 | 470 | 257 | 270 | 132 | 140 | 65 | 69 | 30 | 31 |
| 22 | 477 | 482 | 267 | 279 | 137 | 145 | 68 | 71 | 31 | 32 |
| 23 | 489 | 492 | 277 | 289 | 143 | 150 | 70 | 74 | 32 | 34 |
| 24 | 497 | 499 | 287 | 299 | 148 | 156 | 73 | 77 | 34 | 35 |
| 25 | 500 | 500 | 297 | 309 | 153 | 161 | 76 | 80 | 35 | 36 |
| 26 | | | 307 | 318 | 159 | 166 | 79 | 82 | 36 | 38 |
| 27 | | | 316 | 327 | 164 | 172 | 81 | 85 | 38 | 39 |
| 28 | | | 326 | 337 | 169 | 177 | 84 | 88 | 39 | 40 |
| 29 | | | 335 | 346 | 174 | 182 | 87 | 91 | 40 | 42 |
| 30 | | | 345 | 355 | 179 | 187 | 89 | 93 | 42 | 43 |
| 31 | | | 354 | 364 | 185 | 193 | 92 | 96 | 43 | 44 |
| 32 | | | 363 | 373 | 190 | 198 | 94 | 99 | 44 | 46 |
| 33 | | | 372 | 382 | 195 | 203 | 97 | 101 | 46 | 47 |
| 34 | | | 381 | 391 | 200 | 208 | 100 | 104 | 47 | 48 |
| 35 | | | 390 | 400 | 205 | 213 | 102 | 107 | 48 | 50 |

Appendix 4

## FACTORIAL TREATMENT PROCEDURE WORKSHEETS

Table 1

### 4 TREATMENTS AND 8 ITEMS

Design: 1/2 X $2^4$ (Ref. 15, page 484)

| Treatments | Item numbers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | NONE | + | + | | + | | | + |
| B | | + | | + | | + | | + |
| C | | | + | + | | | + | + |
| D | | | | | + | + | + | + |
| Results | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.
2. Two-factor interactions are confused with one another and are not measurable.
3. Three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 2

5 TREATMENTS AND 8 ITEMS

Design: $1/4 \times 2^5$ (Ref. 15, page 484)

| Treatments | Item numbers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | NONE | + | | + | + | | + | |
| B | | | + | + | + | + | | |
| C | | | + | + | | | + | + |
| D | | + | | + | | + | | + |
| E | | | | | + | + | + | + |
| Results | | | | | | | | |

**Remarks:**

1. All main effects are confused with two-factor interactions.

2. All interactions are assumed negligible.

## Appendix 4

### Table 3

### 6 TREATMENTS AND 8 ITEMS

Design: $1/8 \times 2^6$ (Ref. 15, page 485)

| Treatments | Item numbers 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| A | NONE | + | | + | + | | + | |
| B | | | + | + | | | + | + |
| C | | + | | + | | + | | + |
| D | | | + | + | + | + | | |
| E | | + | + | | | + | + | |
| F | | | | | + | + | + | + |
| Results | | | | | | | | |

**Remarks:**

1. All main effects are confused with two-factor interactions.
2. All interactions are assumed negligible.

Appendix 4

Table 4

7 TREATMENTS AND 8 ITEMS

Design: $1/16 \times 2^7$ (Ref. 15, page 485)

| | Item numbers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Treatments** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | | + | + | + | + | | | |
| B | | + | + | | | + | + | |
| C | | + | | + | | + | | + |
| D | NONE | + | | | + | | + | + |
| E | | | + | + | | | + | + |
| F | | | + | | + | + | | + |
| G | | | | + | + | + | + | |
| Results | | | | | | | | |

**Remarks:**

1. All main effects are confused with two-factor interactions.

2. All interactions are assumed negligible.

Appendix 4

Table 5

7 TREATMENTS AND 8 ITEMS

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | | | | + | | + | + | + |
| B | | | + | | + | + | + | |
| C | | + | | + | + | + | | |
| D | | | + | + | + | | | + |
| E | NONE | + | + | + | | | + | |
| F | | + | + | | | + | | + |
| G | | + | | | + | | + | + |
| Results | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.

2. All interactions are assumed negligible.

Appendix 4

Table 6

8 TREATMENTS AND 12 ITEMS

Design: Multifactorial (Ref. 5, page 323)

| | Item numbers | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| A | | | + | | | | + | + | + | | + | + |
| B | | + | | | | + | + | + | | + | + | |
| C | | | | | + | + | + | | + | + | | + |
| D | NONE | | | + | + | + | | + | + | | + | |
| E | | | + | + | + | | + | + | | + | | |
| F | | + | + | + | | + | + | | + | | | |
| G | | + | + | | + | + | | + | | | | + |
| H | | + | | + | + | | + | | | | + | + |
| Results | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.

2. All interactions are assumed negigible.

Appendix 4

Table 7

9 TREATMENTS AND 12 ITEMS

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | NONE | | + | | | | + | + | + | | + | + |
| B | | + | | | | + | + | + | | + | + | |
| C | | | | | + | + | + | | + | + | | + |
| D | | | | + | + | + | | + | + | | + | |
| E | | | + | + | + | | + | + | | + | | |
| F | | + | + | + | | + | + | | + | | | |
| G | | + | + | | + | + | | + | | | | + |
| H | | + | | + | + | | + | | | | + | + |
| I | | | + | + | | + | | | | + | + | + |
| Results | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.

2. All interactions are assumed negligible.

Appendix 4

Table 8

10 TREATMENTS AND 12 ITEMS

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| A | NONE | | + | | | | + | + | + | | + | + |
| B | | + | | | | + | + | + | | + | + | |
| C | | | | | + | + | + | | + | + | | + |
| D | | | | + | + | + | | + | + | | + | |
| E | | | + | + | + | | + | + | | + | | |
| F | | + | + | + | | + | + | | + | | | |
| G | | + | + | | + | + | | + | | | | + |
| H | | + | | + | + | | + | | | | + | + |
| I | | | + | + | | + | | | | + | + | + |
| J | | + | + | | + | | | | + | + | + | |
| Results | | | | | | | | | | | | |

Remarks:

1. All main effects are confused with interactions.

2. All interactions are assumed negligible.

Appendix 4

Table 9

<u>11 TREATMENTS AND 12 ITEMS</u>

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | + | | | | + | + | + | | + | + |
| B | | + | | | | + | + | + | | + | + | |
| C | | | | | + | + | + | | + | + | | + |
| D | | | | + | + | + | | + | + | | + | |
| E | | | + | + | + | | + | + | | + | | |
| F | NONE | + | + | + | | + | + | | + | | | |
| G | | + | + | | + | + | | + | | | | + |
| H | | + | | + | + | | + | | | | + | + |
| I | | | + | + | | + | | | | + | + | + |
| J | | + | + | | + | | | | + | + | + | |
| K | | + | | + | | | | + | + | + | | + |
| Results | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.

Appendix 4

Table 10

5 TREATMENTS AND 16 ITEMS

Design: 1/2 X $2^5$ (Ref. 6, page 5)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | NONE | + | | + | + | | + | | + | | + | | | + | | + |
| B | | + | | + | + | | + | | | + | | + | + | | + | |
| C | | + | | + | | + | | + | + | | + | | + | | + | |
| D | | + | + | | | + | + | | | + | + | | | + | + | |
| E | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | I | | | | | | | | II | | | | | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.
2. When blocks are not used all two-factor interactions are measurable. When blocks are used the AB interaction is not measurable.
3. All three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 11

5 TREATMENTS AND 16 ITEMS

Design: 1/2 X $2^5$ (Ref. 6, page 5)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | + | + | | + | | | + | + | | | + | | + | + | |
| B | | + | + | | + | | | + | | + | + | | + | | | + |
| C | NONE | + | + | | | + | + | | + | | | + | + | | | + |
| D | | + | | + | + | | + | | + | | + | | | + | | + |
| E | | | + | + | + | + | | | + | + | | | | | + | + |
| Blocks | I | | | | II | | | | III | | | | IV | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.

2. When blocks are not used, all two-factor interactions are measurable.

   When blocks are used, interactions AB, AC, and BC are not measurable.

3. All three-factor and higher order interactions are considered negligible.

Appendix 4

Table 12

6 TREATMENTS AND 16 ITEMS

Design: 1/4 X $2^6$ (Factorial (Ref. 6, page 18)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | NONE | + | + | | + | | | + | + | | | + | | + | + | |
| B | | + | + | | | + | + | | + | | | + | + | | | + |
| C | | + | | + | + | | + | | + | | + | | | + | | + |
| D | | + | | + | | + | | + | + | | + | | + | | + | |
| E | | | + | + | | | + | + | + | + | | | + | + | | |
| F | | | + | + | + | + | | | + | + | | | | | + | + |
| Blocks | I | | | | | | | | II | | | | | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.
2. All two-factor interactions are confused with one another and are not measurable.
3. All three-factor and higher order interactions are assume negligible.

Appendix 4

Table 13

6 TREATMENTS AND 16 ITEMS

Design: 1/4 X $2^6$ Factorial (Ref. 6, page 18)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | NONE | + | + | | + | | | + | + | | | + | | + | + | |
| B | | + | + | | + | | | + | | + | + | | + | | | + |
| C | | + | | + | + | | + | | + | | + | | | + | | + |
| D | | + | | + | + | | + | | | + | | + | + | | + | |
| E | | | + | + | + | + | | | | | + | + | + | + | | |
| F | | | + | + | + | + | | | + | + | | | | | + | + |
| Blocks | I | | | | II | | | | III | | | | IV | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.

2. All two-factor interactions are confused with one another and are not measurable.

3. All three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 14

6 TREATMENTS AND 16 ITEMS

Design: 1/4 X $2^6$ Factorial (Ref. 6, page 18)

| Treatments | Item numbers: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | NONE | + | | + | + | | + | | | + | | + | + | | + | |
| B | | + | | + | + | | + | | + | | + | | | + | | + |
| C | | + | + | | | + | + | | | + | + | | | + | + | |
| D | | + | + | | + | | | + | | + | + | | + | | | + |
| E | | + | + | | | + | + | | + | | | + | + | | | + |
| F | | + | + | | + | | | + | + | | | + | | + | + | |
| Blocks | I | | II | | III | | IV | | V | | VI | | VII | | VIII | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.
2. All two-factor interactions are confused with one another and are not measurable.
3. All three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 15

7 TREATMENTS AND 16 ITEMS

Design: 1/8 X $2^7$ Factorial (Ref. 6, page 30)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | + | + | | + | | | + | | + | + | | + | | | + |
| B | | + | + | | + | | | + | + | | | + | | + | + | |
| C | | + | + | | | + | + | | | + | + | | | + | + | |
| D | NONE | + | + | | | + | + | | + | | | + | + | | | + |
| E | | + | | + | + | | + | | | + | | + | + | | + | |
| F | | + | | + | | + | | + | + | | + | | + | | + | |
| G | | + | | + | + | | + | | + | | + | | | + | | + |
| Blocks | I | | | | | | | | II | | | | | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.
2. All two-factor interactions are confused with one another and are not measurable.
3. All three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 16

7 TREATMENTS AND 16 ITEMS

Design: 1/8 X $2^7$ Factorial (Ref. 6, page 30)

| | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | NONE | + | + | | + | | | + | | + | + | | + | | | + |
| B | | + | + | | + | | | + | + | | | + | | + | + | |
| C | | + | + | | | + | + | | | + | + | | | + | + | |
| D | | + | + | | | + | + | | + | | | + | + | | | + |
| E | | + | | + | + | | + | | | + | | + | + | | + | |
| F | | + | | + | | + | | + | + | | + | | + | | + | |
| G | | + | | + | + | | + | | + | | + | | | + | | + |
| Blocks | I | | | | II | | | | III | | | | IV | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.

2. All two-factor interactions are confused with one another and are not measurable.

3. All three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 17

8 TREATMENTS AND 16 ITEMS

Design: 1/16 X $2^8$ Factorial (Ref. 6, page 42)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | | + | + | + | + | | | + | + | | | | | + | + |
| B | | | + | + | + | + | | | | | + | + | + | + | | |
| C | | + | + | | + | | | + | + | | | + | | + | + | |
| D | | + | + | | + | | | + | | + | + | | + | | | + |
| E | NONE | + | | + | + | | + | | | + | | + | + | | + | |
| F | | + | | + | + | | + | | + | | + | | | + | | + |
| G | | | | | + | + | + | + | + | + | + | + | | | | |
| H | | | | | + | + | + | + | | | | | + | + | + | + |
| Blocks | I | | | | | | | | II | | | | | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.
2. All two-factor interactions are confused with one another and are not measurable.
3. All three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 18

8 TREATMENTS AND 16 ITEMS

Design: 1/16 X $2^8$ Factorial (Ref. 6, page 41)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | + | + | | + | | | + | | + | + | | + | | | + |
| B | | + | + | | | + | + | | | + | + | | | + | + | |
| C | | + | + | | + | | | + | + | | | + | | + | + | |
| D | | + | + | | | + | + | | + | | | + | + | | | + |
| E | NONE | | + | + | | | + | + | + | + | | | + | + | | |
| F | | | + | + | + | + | | | + | + | | | | | + | + |
| G | | | + | + | + | + | | | | | + | + | + | + | | |
| H | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | I | | | | II | | | | III | | | | IV | | | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are clear of two-factor interactions.
2. All two-factor interactions are confused with one another and are not measurable.
3. All three-factor and higher order interactions are assumed negligible.

Appendix 4

Table 19

9 TREATMENTS AND 16 ITEMS

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | NONE | | | | + | | | + | + | | + | | + | + | + | + |
| B | | | | + | | | + | + | | + | | + | + | + | + | |
| C | | | + | | | + | + | | + | | + | + | + | + | | |
| D | | + | | | + | + | | + | | + | + | + | + | | | |
| E | | | | + | + | | + | | + | + | + | + | | | | + |
| F | | | + | + | | + | | + | + | + | + | | | | + | |
| G | | + | + | | + | | + | + | + | + | | | | + | | |
| H | | + | | + | | + | + | + | + | | | | + | | | + |
| I | | | + | | + | + | + | + | | | | + | | | + | + |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.

Appendix 4

Table 20

<u>10 TREATMENTS AND 16 ITEMS</u>

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | | | | + | | | + | + | | + | | + | + | + | + |
| B | | | | + | | | + | + | | + | | + | + | + | + | |
| C | | | + | | | + | + | | + | | + | + | + | + | | |
| D | | + | | | + | + | | + | | + | + | + | + | | | |
| E | NONE | | | + | + | | + | | + | + | + | + | | | | + |
| F | | | + | + | | + | | + | + | + | + | | | | + | |
| G | | + | + | | + | | + | + | + | + | | | | + | | |
| H | | + | | + | | + | + | + | + | | | | + | | | + |
| I | | | + | | + | + | + | + | | | | + | | | + | + |
| J | | + | | + | + | + | + | | | | + | | | + | + | |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.

Appendix 4

Table 21

11 TREATMENTS AND 16 ITEMS

Design: Multifactorial (Ref. 5, page 323)

| | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treatments** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| **A** | | | | | + | | | + | + | | + | | + | + | + | + |
| **B** | | | | + | | | + | + | | + | | + | + | + | + | |
| **C** | | | + | | | + | + | | + | | + | + | + | + | | |
| **D** | | + | | | + | + | | + | | + | + | + | + | | | |
| **E** | | | | + | + | | + | | + | + | + | + | | | | + |
| **F** | NONE | | + | + | | + | | + | + | + | + | | | | + | |
| **G** | | + | + | | + | | + | + | + | + | | | | + | | |
| **H** | | + | | + | | + | + | + | + | | | | + | | | + |
| **I** | | | + | | + | + | + | + | | | | + | | | + | + |
| **J** | | + | | + | + | + | + | | | | + | | | + | + | |
| **K** | | | + | + | + | + | | | | + | | | + | + | | + |
| **Results** | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.

Appendix 4

Table 22

<u>12 TREATMENTS AND 16 ITEMS</u>

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | | | | + | | | + | + | | + | | + | + | + | + |
| B | | | | + | | | + | + | | + | | + | + | + | + | |
| C | | | + | | | + | + | | + | | + | + | + | + | | |
| D | | + | | | + | + | | + | | + | + | + | + | | | |
| E | | | | + | + | | + | | + | + | + | + | | | | + |
| F | | | + | + | | + | | + | + | + | + | | | | + | |
| G | NONE | + | + | | + | | + | + | + | + | | | | + | | |
| H | | + | | + | | + | + | + | + | | | | + | | | + |
| I | | | + | | + | + | + | + | | | | + | | | + | + |
| J | | + | | + | + | + | + | | | | + | | | + | + | |
| K | | | + | + | + | + | | | | + | | | + | + | | + |
| L | | + | + | + | + | | | | + | | | + | + | | + | |
| Results | | | | | | | | | | | | | | | | |

**<u>Remarks</u>:**

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.

Appendix 4

Table 23

13 TREATMENTS AND 16 ITEMS

Design: Multifactorial (Ref. 5, page 323)

| | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treatments** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | | | | + | | | + | + | | + | | + | + | + | + |
| B | | | | + | | | + | + | | + | | + | + | + | + | |
| C | | | + | | | + | + | | + | | + | + | + | + | | |
| D | | + | | | + | + | | + | | + | + | + | + | | | |
| E | | | | + | + | | + | | + | + | + | + | | | | + |
| F | | | + | + | | + | | + | + | + | + | | | | + | |
| G | | + | + | | + | | + | + | + | + | | | | + | | |
| H | NONE | + | | + | | + | + | + | + | | | | + | | | + |
| I | | | + | | + | + | + | + | | | | + | | | + | + |
| J | | + | | + | + | + | + | | | | + | | | + | + | |
| K | | | + | + | + | + | | | | + | | | + | + | | + |
| L | | + | + | + | + | | | | + | | | + | + | | + | |
| M | | + | + | + | | | | + | | | + | + | | + | | + |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.

Appendix 4

Table 24

<u>14 TREATMENTS AND 16 ITEMS</u>

Design: Multifactorial (Ref. 5, page 323)

| Treatments | Item numbers 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | NONE | | | | + | | | + | + | | + | | + | + | + | + |
| B | | | | + | | | + | + | | + | | + | + | + | + | |
| C | | | + | | | + | + | | + | | + | + | + | + | | |
| D | | + | | | + | + | | + | | + | + | + | + | | | |
| E | | | | + | + | | + | | + | + | + | + | | | | + |
| F | | | + | + | | + | | + | + | + | + | | | | + | |
| G | | + | + | | + | | + | + | + | + | | | | + | | |
| H | | + | | + | | + | + | + | + | | | | + | | | + |
| I | | | + | | + | + | + | + | | | | + | | | + | + |
| J | | + | | + | + | + | + | | | | + | | | + | + | |
| K | | | + | + | + | + | | | | + | | | + | + | | + |
| L | | + | + | + | + | | | | + | | | + | + | | + | |
| M | | + | + | + | | | | + | | | + | + | | + | | + |
| N | | + | + | | | | + | | | + | + | | + | | + | + |
| Results | | | | | | | | | | | | | | | | |

**Remarks:**

1. All main effects are confused with interactions.

2. All interactions are assumed negligible.

Appendix 4

Table 25

<u>15 TREATMENTS AND 16 ITEMS</u>

Design: Multifactorial (Ref. 5, page 323)

| | Item numbers | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Treatments** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| A | | | | | + | | | + | + | | + | | + | + | + | + |
| B | | | | + | | | + | + | | + | | + | + | + | + | |
| C | | | + | | | + | + | | + | | + | + | + | + | | |
| D | | + | | | + | + | | + | | + | + | + | + | | | |
| E | | | | + | + | | + | | + | + | + | + | | | | + |
| F | | | + | + | | + | | + | + | + | + | | | | + | |
| G | | + | + | | + | | + | + | + | + | | | | + | | |
| H | NONE | + | | + | | + | + | + | + | | | | + | | | + |
| I | | | + | | + | + | + | + | | | | + | | | + | + |
| J | | + | | + | + | + | + | | | | + | | | + | + | |
| K | | | + | + | + | + | | | | + | | | + | + | | + |
| L | | + | + | + | + | | | | + | | | + | + | | + | |
| M | | + | + | + | | | | + | | | + | + | | + | | + |
| N | | + | + | | | | + | | | + | + | | + | | + | + |
| O | | + | | | | + | | | + | + | | + | | + | + | + |
| Results | | | | | | | | | | | | | | | | |

**<u>Remarks:</u>**

1. All main effects are confused with interactions.

2. All interactions are assumed negligible.

3. The treatment combinations in the individual rows of this design can be used in any combination of two or more, up to and including 15 treatments.

APPENDIX 4

Table 26

19 Treatments and 20 Items

**Design: Multifactorial** (Ref. 5, page 323)

| Treatments | Item numbers | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| A | | | + | + | | | | | + | | + | | + | + | + | + | | | + | + |
| B | | + | + | | | | | + | | + | | + | + | + | + | | | + | + | |
| C | | + | | | | | + | | + | | + | + | + | + | | | + | + | | + |
| D | | | | | | + | | + | | + | + | + | + | | | + | + | | + | + |
| E | | | | | + | | + | | + | + | + | + | | | + | + | | + | + | |
| F | | | | + | | + | | + | + | + | + | | | + | + | | + | + | | |
| G | | | + | | + | | + | + | + | + | | | + | + | | + | + | | | |
| H | | + | | + | | + | + | + | + | | | + | + | | + | + | | | | |
| I | | | + | | + | + | + | + | | | + | + | | + | + | | | | | + |
| J | | + | | + | + | + | + | | | + | + | | + | + | | | | | + | |
| K | | | + | + | + | + | | | + | + | | + | + | | | | | + | | + |
| L | | + | + | + | + | | | + | + | | + | + | | | | | + | | + | |
| M | | + | + | + | | | + | + | | + | + | | | | | + | | + | | + |
| N | | + | + | | | + | + | | + | + | | | | | + | | + | | + | + |
| O | | + | | | + | + | | + | + | | | | | + | | + | | + | + | + |
| P | | | | + | + | | + | + | | | | | + | | + | | + | + | + | + |
| Q | | | + | + | | + | + | | | | | + | | + | | + | + | + | + | |
| R | | + | + | | + | + | | | | | + | | + | | + | + | + | + | | |
| S | | + | | + | + | | | | | + | | + | | + | + | + | + | | | + |
| Results | | | | | | | | | | | | | | | | | | | | |

<u>Remarks:</u>

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.
3. The treatment combinations in the individual rows of this design can be used in any combination of two or more, up to and including 19 treatments.

## APPENDIX 4

Table 27
23 Treatment and 24 Items
Design: Multifactorial (Ref. 5, page 323)

| Treat- ments | ITEM NUMBERS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | + | | + | | | + | + | | | + | + | | + | | + | + | + | + | + |
| B | | | | | + | | + | | | + | + | | | + | + | | + | | + | + | + | + | + | |
| C | | | | + | | + | | | + | + | | | + | + | | + | | + | + | + | + | + | | |
| D | | | + | | + | | | + | + | | | + | + | | + | | + | + | + | + | + | | | |
| E | | + | | + | | | + | + | | | + | + | | + | | + | + | + | + | + | | | | |
| F | | | + | | | + | + | | | + | + | | + | | + | + | + | + | + | | | | | + |
| G | | + | | | + | + | | | + | + | | + | | + | + | + | + | + | | | | | + | |
| H | | | | + | + | | | + | + | | + | | + | + | + | + | + | | | | | + | | + |
| I | | | + | + | | | + | + | | + | | + | + | + | + | + | | | | | + | | + | |
| J | | + | + | | | + | + | | + | | + | + | + | + | + | | | | | + | | + | | |
| K | | + | | | + | + | | + | | + | + | + | + | + | | | | | + | | + | | | + |
| L | NONE | | | + | + | | + | | + | + | + | + | + | | | | | + | | + | | | + | + |
| M | | | + | + | | + | | + | + | + | + | + | | | | | + | | + | | | + | + | |
| N | | + | + | | + | | + | + | + | + | + | | | | | + | | + | | | + | + | | |
| O | | + | | + | | + | + | + | + | + | | | | | + | | + | | | + | + | | | + |
| P | | | + | | + | + | + | + | + | | | | | + | | + | | | + | + | | | + | + |
| Q | | + | | + | + | + | + | + | | | | | + | | + | | | + | + | | | + | + | |
| R | | | + | + | + | + | + | | | | | + | | + | | | + | + | | | + | + | | + |
| S | | + | + | + | + | + | | | | | + | | + | | | + | + | | | + | + | | + | |
| T | | + | + | + | + | | | | | + | | + | | | + | + | | | + | + | | + | | + |
| U | | + | + | + | | | | | + | | + | | | + | + | | | + | + | | + | | + | + |
| V | | + | + | | | | | + | | + | | | + | + | | | + | + | | + | | + | + | + |
| W | | + | | | | | + | | + | | | + | + | | | + | + | | + | | + | + | + | + |
| Results | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are confused with interactions.
2. All interactions are assumed negligible.
3. The treatment combinations in the individual rows of this design can be used in any combination of two or more up to and including 23 treatments.

Table 28
27 Treatments and 28 Items
Design: Multifactorial (Ref. 5, page 323)

| Treat- | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ments | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| A | | + | | + | + | | + | | + | + | + | | | + | | | | + | | | | | + | + | + | + | | + |
| B | | | + | + | | + | + | + | + | | | | + | | | + | + | | | | | | + | + | + | | + | + |
| C | | + | + | | + | + | | + | | + | | + | | | + | | | | + | | | | + | + | + | + | + | |
| D | | + | | + | | + | + | + | | + | + | | | | + | | + | | | + | + | + | + | | + | | | |
| E | | | + | + | + | + | | | + | + | | | + | + | | | | | + | + | + | + | | + | + | | | |
| F | | + | + | | + | | + | + | + | | | + | | | | + | | + | | + | + | + | + | + | | | | |
| G | | | + | + | + | | + | + | | + | | + | | + | | | + | | | + | | + | | | | + | + | + |
| H | | + | + | | | + | + | | + | + | + | | | | | + | | | + | | + | + | | | | + | + | + |
| I | | + | | + | + | + | | + | + | | | | + | | + | | | + | | + | + | | | | | + | + | + |
| J | | + | | | + | | | | + | | | | | + | + | + | + | | + | + | | + | + | | + | | + | + |
| K | | | | + | | | + | + | | | | | | + | + | + | | + | + | | + | + | | + | + | + | + | |
| L | E | | + | | | + | | | | + | | | | + | + | + | + | + | | + | + | | + | + | | + | | + |
| M | N | + | | | | + | | + | | | + | + | + | + | | + | | | | + | | + | | + | + | + | | + |
| N | O | | | + | + | | | | | + | + | + | + | | + | + | | | | | + | + | + | + | | | + | + |
| C | N | | + | | | | + | | + | | + | + | + | + | + | | | | | + | + | | + | | + | + | + | |
| P | | | + | | + | | | + | | | + | | + | | | | + | + | + | | + | + | + | | + | + | | + |
| Q | | + | | | | | + | | | + | | + | + | | | | + | + | + | + | + | | | + | + | | + | + |
| R | | | | + | | + | | | + | | + | + | | | | | + | + | + | + | | + | + | + | | + | + | |
| S | | | | | + | + | + | + | | + | + | | + | + | | + | | + | + | + | | | + | | | | + | |
| T | | | | | + | + | + | | + | + | | + | + | | + | + | + | + | | | | + | | | + | + | | |
| U | | | | | + | + | + | + | + | | + | + | | + | + | | + | | + | | + | | | + | | | | + |
| V | | + | + | + | + | | + | | | | + | | + | | + | + | + | | + | + | | | | + | | + | | |
| W | | + | + | + | | + | + | | | | | + | + | + | + | | | + | + | | | + | + | | | | | + |
| X | | + | + | + | + | + | | | | | + | + | | + | | + | + | + | | | + | | | | + | | + | |
| Y | | + | | + | | | | + | + | + | | + | + | + | | + | + | | + | | + | | + | | | + | | |
| Z | | | + | + | | | | + | + | + | + | + | | | + | + | | + | + | + | | | | | + | | | + |
| ZZ | | + | + | | | | | + | + | + | + | | + | + | + | | + | + | | | | + | | + | | | + | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



Remarks:
1. All main effects are confused with interactions.
2. All interactions are assumed negligible.
3. The treatment combinations in the individual rows of this design can be used in any combination of two or more up to and including 27 treatments.

APPENDIX 4

Table 29
6 Treatments and 32 Items
Design: $1/2 \times 2^6$ Factorial (Ref. 6, page 7)

| Treat-ments | ITEM NUMBERS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| B | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | |
| C | | + | + | | + | | | + | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | |
| D | NONE | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + |
| E | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | |
| F | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | I | | | | | | | | | | | | | | | | II | | | | | | | | | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. All two-factor interactions are measurable.
3. All three-factor and higher order interactions are assumed negligible.

# APPENDIX 4

Table 30
6 Treatments and 32 Items
Design: 1/2 X $2^6$ Factorial (Ref. 6, page 6)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | | | | + | + | | | + | + |
| B | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| C | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + |
| D | NONE | | + | + | + | + | | | | | + | + | + | + | | | + | + | | | | | + | + | + | + | | | | | + | + |
| E | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + |
| F | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | | | + | | + | | + | | + |
| BLOCKS | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. When blocks are not used, all two-factor interactions are measurable. When blocks are used, interaction BC is not measurable.
3. All three-factor and higher order interactions are assumed negligible.

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Table 31
6 Treatments and 32 Items
Design: 1/2 X $2^6$ Factorial (Ref. 6, page 6)

| Treatments | ITEM NUMBERS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | + | + | + | + | | | + | + | | | | | + | + |
| B | | + | + | | | + | + | | + | | | + | + | | | + |
| C | | + | + | | + | | | + | | + | + | | + | | | + |
| D | NONE | | + | + | | | + | + | | | + | + | | | + | + |
| E | | + | | + | + | | + | | + | | + | | | + | | + |
| F | | + | | + | + | | + | | + | | + | | | + | | + |
| BLOCKS | I | | | | II | | | | III | | | | IV | | | |
| Results | | | | | | | | | | | | | | | | |

| Treatments | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | + | + | + | + | | | + | + | | | | | + | + |
| B | + | | | + | + | | | + | | + | + | | | + | + | |
| C | + | | | + | | + | + | | + | | | + | | + | + | |
| D | + | + | | | + | + | | | + | + | | | + | + | | |
| E | + | | + | | | + | | + | | + | | + | + | | + | |
| F | | + | | + | + | | + | | + | | + | | | + | | + |
| BLOCKS | V | | | | VI | | | | VII | | | | VIII | | | |
| Results | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. When blocks are not used, all two factor interactions are measurable. When blocks are used, interactions AD, BC, & EF are not measurable.
3. All three-factor and higher order interactions are assumed negligible.

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Table 32
7 Treatments and 32 Items
Design: $1/4 \times 2^7$ Factorial (Ref. 6, page 20)

| Treat- ments | ITEM NUMBERS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | | | + | + | + | + | + | + | + | + | | | | | | | | | + | + | + | + | + | + | + | + | | | | |
| B | | | | | + | + | + | + | + | + | + | + | | | | | + | + | + | + | | | | | | | | | + | + | + | + |
| C | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| D | NONE | | | | + | + | + | + | | | | | + | + | + | + | + | + | + | + | | | | | + | + | + | + | | | | |
| E | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + |
| F | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + |
| G | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | I | | | | | | | | | | | | | | | | II | | | | | | | | | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are free of two-factor interactions.
2. When blocks are not used interactions AB, AC, AE, BC, BE and CE are not measurable. When blocks are used interactions AB, AD, AF, BD, BF and DF are not measurable.
3. All three-factor and higher order interactions are assumed negligible.

## APPENDIX 4

Table 33
7 Treatments and 32 Items
Design: $1/4 \times 2^7$ Factorial (Ref. 6, page 19)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | | | + | + | | + | | | + |
| B | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | | | + | | + | | + | | + |
| C | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| D | NONE | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | | | | + | + | | | + | + |
| E | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| F | | | + | + | | | + | + | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | |
| G | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + |
| Blocks | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are free of two-factor interactions.
2. When blocks are not used interactions AB, AC, AE, BC, BE and CE are not measurable.
   When blocks are used interactions AB, AC, AE, BC, BE, CE and DF are not measurable.
3. All three-factor and higher order interactions are assumed negligible.

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Table 34
7 Treatments and 32 Items
Design: 1/4 X $2^7$ Factorial (Ref. 6, page 19)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| B | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| C | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | | | + | | + | | + | | + |
| D | NONE | | + | + | + | + | | | + | + | | | | | + | + | + | + | | | | | + | + | | | + | + | + | + | | |
| E | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | | | + | + | | + | | | + |
| F | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + |
| G | | | + | + | + | + | | | | | + | + | + | + | | | + | + | | | | | + | + | + | + | | | | | + | + |
| Blocks | I | | | | II | | | | III | | | | IV | | | | V | | | | VI | | | | VII | | | | VIII | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. When blocks are not used, interactions AB, AC, AE, BC, BE and CE are not measurable. When blocks are used only interactions AD, AF, AG, BD, BF, BG, CD, CF, CG, EF, EG and DE are measurable.
3. All three-factor and higher order interactions are assumed negligible.

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Table 35
8 Treatments and 32 Items
Design: 1/8 X $2^8$ Factorial (Ref. 6, page 31)

| Treatments | ITEM NUMBERS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | + | | + | + | | + | | + | | + | | | + | + | | | + | | + | + | | + | | + | | + | | | + | | + |
| B | | + | | + | + | | + | | | + | | + | + | | | + | | + | | + | + | | + | | | + | | + | + | | + | |
| C | | + | | + | + | | + | | + | | + | | | + | + | | + | | + | | | + | | + | | + | | + | + | | + | |
| D | NONE | + | | + | + | | + | | | + | | + | + | | | + | + | | + | | | + | | + | + | | + | | | + | | + |
| E | | + | + | | | + | + | | + | | | + | + | | + | | | + | + | | | + | + | | + | | | + | + | | | + |
| F | | + | | + | | + | | + | + | | + | | + | | | + | + | | + | | + | | + | | | + | | + | | + | | + |
| G | | + | | + | | + | | + | + | | + | | + | | | + | | + | | + | | + | | + | + | | + | | + | | + | |
| H | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | |
| Blocks | I | | | | | | | | | | | | | | | | II | | | | | | | | | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. Only the following interactions are measurable: AE, AH, BE, BH, CE, CH, DE, DH, EF, EG, EH, FH and GH whether or not blocks are used.
3. All three-factor and higher order interactions are assumed negligible.

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Table 36
8 Treatments and 32 Items
Design: 1/8 X $2^8$ Factorial (Ref. 6, page 31)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | | + | + | + | + | | | + | + | | | | | + | + | + | + | | | | | + | + | | | + | + | + | + | | |
| B | | | | | + | + | + | + | + | + | + | + | | | | | + | + | + | + | | | | | | | | | + | + | + | + |
| C | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | | | + | + | | + | | | + |
| D | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| E | NONE | + | | + | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | |
| F | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| G | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | | | | + | + | | | + | + |
| H | | + | | + | | + | | + | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | |
| Blocks | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. When blocks are not used interactions AE, AH, BE, BH, CE, CH, DE, DH, EF, EG, EH, FH and GH are measurable. When blocks are used interactions AE, AH, BE, BH, CE, CH, DE, DH, EF, EG, FH and GH are measurable.
3. All three-factor and higher order interactions are assumed negligible.

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Table 37
8 Treatments and 32 Items
Design: 1/8 X $2^8$ Factorial (Ref. 6, page 30)

| Treat-ments | ITEM NUMBERS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | |
| B | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + |
| C | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | | | + | + | | + | | | + |
| D | NONE | + | + | | + | | | + | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | |
| E | | + | | + | | + | | + | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | |
| F | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| G | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + |
| H | | | + | + | | | + | + | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | |
| Blocks | I | | | | II | | | | III | | | | IV | | | | V | | | | VI | | | | VII | | | | VIII | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. Only the following interactions are measurable: AE, AH, BE, BH, CE, CH, DE, DH, EF, EG, EH, FH and GH whether or not blocks are used.
3. All three-factor and higher order interactions are assumed negligible.

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Table 38
9 Treatments and 32 Items
Design: 1/16 X $2^9$ Factorial (Ref. 6, page 43)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| B | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| C | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| D | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + |
| E | NONE | | + | + | + | + | | | | | + | + | + | + | | | + | + | | | | | + | + | + | + | | | | | + | + |
| F | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | |
| G | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + |
| H | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | | | | + | + | | | + | + |
| I | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + |
| Blocks | I | | | | | | | | | | | | | | | | II | | | | | | | | | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



Remarks:
1. All main effects are clear of two-factor interactions.
2. Only the following interactions are measurable: AH, AI, BH, BI, CH, CI, DH, DI, EH, EI, FH, FI, GH, GI and HI whether or not blocks are used.
3. All three-factor and higher order interactions are assumed negligible.

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Table 39
9 Treatments and 32 Items
Design: $1/16 \times 2^9$ Factorial (Ref. 6, Page 42)

| Treat-ments | ITEM NUMBERS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + |
| B | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| C | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| D | NONE | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| E | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + |
| F | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | |
| G | | | + | + | + | + | | | | | + | + | + | + | | | + | + | | | | | + | + | + | + | | | | | + | + |
| H | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | | | | + | + | | | + | + |
| I | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + |
| Blocks | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Remarks:**
1. All main effects are clear of two-factor interactions.
2. Only the following interactions are measurable: AH, AI, BH, BI, CH, CI, DH, DI, EH, EI, FH, FI, GH, GI and HI whether or not blocks are used.
3. All three-factor and higher order interactions are assumed negligible.

Table 40
9 Treatments and 32 Items
Design: $1/16 \times 2^9$ Factorial (Ref. 6, page 42)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | + | | + | | | + | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | |
| B | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| C | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | | | + | + | | + | | | + |
| D | NONE | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| E | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + |
| F | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| G | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + |
| H | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + |
| I | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | I | | | | II | | | | III | | | | IV | | | | V | | | | VI | | | | VII | | | | VIII | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. Only the following interactions are measurable: AH, AI, BH, BI, CH, CI, DH, DI, EH, EI, FH, FI, GH, GI and HI whether or not blocks are used.
3. All three-factor and higher order interactions are assumed negligible.

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Table 41
10 Treatments and 32 Items
Design: 1/32 X $2^{10}$ Factorial (Ref. 6, page 53)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | |
| B | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | | | + | | + | | + | | + |
| C | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| D | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + |
| E | NONE | + | | + | + | | + | | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + |
| F | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | |
| G | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| H | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| I | | | + | + | | | + | + | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | |
| J | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | I | | | | | | | | | | | | | | | | II | | | | | | | | | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. None of the two-factor interactions are measurable.
3. All three-factor and higher order interactions are assumed negligible.

# APPENDIX 4

Table 42
10 Treatments and 32 Items
Design: $1/32 \times 2^{10}$ Factorial (Ref. 6, page 52)

| | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treat-ments | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | |
| B | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | | | + | | + | | + | | + |
| C | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| D | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + |
| E | | + | | + | + | | + | | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + |
| F | NONE | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | |
| G | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| H | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| I | | | + | + | | | + | + | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | |
| J | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | | | | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. None of the two-factor interactions are measurable.
3. All three-factor and higher order interactions are assumed negligible.

APPENDIX 4

Table 43
10 Treatments and 32 Items
Design: 1/32 X $2^{10}$ Factorial (Ref. 6, page 52)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | |
| B | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | | | + | | + | | + | | + |
| C | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| D | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + |
| E | NONE | + | | + | + | | + | | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + |
| F | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | |
| G | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| H | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| I | | | + | + | | | + | + | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | |
| J | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| Blocks | I | | | | II | | | | III | | | | IV | | | | V | | | | VI | | | | VII | | | | VIII | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. None of the two-factor interactions are measurable..
3. All three-factor and higher order interactions are assumed negligible.

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Table 44
11 Treatments and 32 Items
Design: 1/64 X $2^{11}$ Factorial (Ref. 6, page 58)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| B | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| C | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| D | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + |
| E | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | |
| F | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| G | NONE | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | + | + | | | + | + | | |
| H | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | |
| I | | | + | + | + | + | | | | | + | + | + | + | | | + | + | | | | | + | + | + | + | | | | | + | + |
| J | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + |
| K | | + | + | | + | | | + | | + | + | | + | | | + | + | | | + | | + | + | | + | | | + | | + | + | |
| Blocks | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. None of the two-factor interactions are measurable.
3. All three-factor and higher order interactions are assumed negligible.

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Table 45
12 Treatments and 32 Items
Design: 1/128 X $2^{12}$ Factorial (Ref. 6, page 65)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | |
| B | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| C | | + | | + | + | | + | | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + |
| D | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + |
| E | | | | | + | + | + | + | | | | | + | + | + | + | + | + | + | + | | | | | + | + | + | + | | | | |
| F | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + | | | | | + | + | + | + |
| G | NONE | | + | + | | | + | + | | | + | + | | | + | + | + | + | | | + | + | | | + | + | | | + | + | | |
| H | | | + | + | | | + | + | + | + | | | + | + | | | | | + | + | | | + | + | + | + | | | + | + | | |
| I | | | | | + | + | + | + | + | + | + | + | | | | | + | + | + | + | | | | | | | | | + | + | + | + |
| J | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + |
| K | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + |
| L | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| Blocks | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. None of the two-factor interactions are measurable.
3. All three-factor and higher order interactions are assumed negligible.

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Table 46
13 Treatments and 32 Items
Design: 1/256 X $2^{13}$ Factorial (Ref. 6, page 74)

| Treat-ments | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| A | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | | | + | + | |
| B | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + | | + |
| C | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | |
| D | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + | | + | + | | + | | | + |
| E | | + | | + | | + | | + | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | |
| F | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + |
| G | NONE | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + | | + | | + | + | | + | |
| H | | + | | + | + | | + | | | + | | + | + | | + | | + | | + | | | + | | + | + | | + | | | + | | + |
| I | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + | | + | + | | | + | + | |
| J | | + | | + | | + | | + | + | | + | | + | | + | | + | | + | | + | | + | | | + | | + | | + | | + |
| K | | + | | + | | + | | + | + | | + | | + | | + | | | + | | + | | + | | + | + | | + | | + | | + | |
| L | | + | + | | | + | + | | | + | + | | | + | + | | + | | | + | + | | | + | + | | | + | + | | | + |
| M | | + | + | | + | | | + | + | | | + | | + | + | | | + | + | | + | | | + | + | | | + | | + | + | |
| Blocks | I | | | | | | | | II | | | | | | | | III | | | | | | | | IV | | | | | | | |
| Results | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:
1. All main effects are clear of two-factor interactions.
2. None of the two-factor interactions are measurable.
3. All three-factor and higher order interactions are assumed negligible.

336

Table 47

31 Treatments and 32 Items

Design: Multifactorial (Ref. 5, page 323)

| Treat-ments | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ITEM NUMBERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | + | | | + | | + | + | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | |
| B | | | | + | | + | + | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + |
| C | | | + | | + | + | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | |
| D | | + | | + | + | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | |
| E | | | + | + | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + |
| F | | + | + | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | |
| G | | + | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + |
| H | | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + |
| I | | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | |
| J | | + | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | |
| K | | + | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + |
| L | | + | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + |
| M | | + | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + |
| N | E | + | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + |
| O | N | | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + |
| P | O | | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | |
| Q | N | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | |
| R | | + | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + |
| S | | + | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + |
| T | | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | |
| U | | + | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | | |
| V | | + | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + |
| W | | + | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + | + |
| X | | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + | + | + |
| Y | | + | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | [illegible] | + | + | |
| Z1 | | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + | + | + | | + |
| Z2 | | + | | | | | + | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + | + | + | | + | |
| Z3 | | | | | + | | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + | + | + | | + | | + |
| Z4 | | | | + | | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + | + | + | | + | | + | |
| Z5 | | | + | | | | + | | + | + | | | + | + | + | + | + | | | + | + | | | + | + | + | | + | | + | | |
| Z6 | | + | | | + | | | + | + | | | + | + | + | + | + | | | + | + | | | + | + | + | | + | | + | | | |
| Results: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Remarks:

1. All main effects are confused with interactions.
2. All interactions are assumed negligible.
3. The treatment combinations in the individual rows of this design can be used in any combination of two or more up to and including 31 treatments.

## APPENDIX 5

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